# POWER

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# Fifty Years of Steam

THE Babcock & Wilcox Company is commemorating the fiftieth anniversary of its incorporation by the publication of a brochure under the above title.

It covers the history not only of the company but of the partnership which preceded it, from the invention of the "safety water-tube boiler" by George H. Babcock and Stephen Wilcox in 1867 to the present organization comprising every essential to modern practice in the making of steam.

Few realize now how completely this intensely living age is dependent upon power not only for its release from physical drudgery but for its cultural advantages and, indeed, for its existence.

And industrial power is still and will long be dependent for its generation upon the burning of fuel under boilers.

It has been a factor too little appreciated in the development of the steam boiler from the small beginnings with which this history starts to the modern marvels of capacity, safety and efficiency that there should have been such an organization available for meeting the demands of progress.

The experience of the company comprises the entire evolution of modern methods of steam generation. Its organization is equipped not only to conserve that experience but to grapple with the problems of advancing practice and to explore the possibilities of the untried.

It is qualified to dependably pass upon the practicability of suggested advances and able to stake hundreds of thousands of dollars upon the successful outcome of ventures which it approves and in the carrying out of which it is interested to cooperate.

It is safe to say that the remarkable development that has equalized the past half-century of power plant engineering is not only coincident with the corporate existence of the Babcock & Wilcox Company but is indissolubly linked with and abundantly beholden to it.

# EDITORIALS

## Engineer Economists

THE FACT that a theory works is no proof that it is correct. Scientists have long since discarded the notion that most of our scientific "laws" are absolute and universal in application. They claim merely that the accepted laws serve conveniently to predict facts over a limited area of application.

Scientists devise theories to cover the known facts. With their aid new facts are discovered, including some that won't jibe. Then the original theories must be modified to embrace the larger circle of knowledge.

If this constant correction of theory to accord with new knowledge is necessary in the field of physics, how much more is it needed in fields where complex human relations are involved? Yet the impression prevails, apparently, that the economic "laws" governing such relations are well-established and that they are not subject to correction. Too often an attempt is made to trim the facts to fit the supposed laws, instead of revising the laws into accordance with the present-day accumulation of economic data.

This point is raised for a very practical reason. The whole world at present is faced with major economic and social problems. Unemployment, wages, foreign trade, dictatorship, communism, farm relief, overproduction, mechanization are words on every tongue. Read the papers and note the many "letters from readers," each with a definite plan for saving the world—strong opinions, pointing in all directions and each claiming foundation on some economic law.

To evolve some order from this chaos of opinion we seem to need, above all else, a reexamination and, where necessary, readjustment of economic laws in the light of known facts.

In this process the engineer, as he becomes more economically minded, will play a constructive part. In one field at least he has learned to think long and closely before delivering a conclusion. He knows that an efficient boiler or engine, low in cost, reliable and easy to operate, is not designed in ten minutes. He can well conceive that a longer period may be required to solve the world's economic problems. He will see the value of facts assembled for the checking and revision of existing theories.

In touch alike with abstract thought on the one hand, and with business and industry on the other, he is exceptionally free from the bias that so often affects both academicians and business men. By training and by temperament he is particularly well-fitted to encourage saner and more fundamental economic thinking.

## Elevator Room Ventilation Needs Further Study

WHERE heat is produced it must be dissipated or the temperature will increase to a destructive value. This simple principle has frequently been overlooked by architects and engineers in designing elevator machine rooms. Practically all the power supplied to a passenger elevator machine, over the period of a day, appears as heat in the machine room. On this basis, an elevator machine running three car-miles per hour and requiring four kilowatt-hours per car-mile may be considered the equivalent of a twelve-kilowatt electric heater in the machine room. It is obvious that five to ten such heaters in a room without ventilation will soon raise the air temperature to a point where it will be dangerous to electrical insulation. If good natural ventilation is not available, then artificial means must be provided. The time to do this is when the building is designed, not after it is found impossible to operate the machines.

Artificial ventilation of elevator rooms is not an added expense to the building without compensation. Where the ventilating air is filtered a large part of the dirt that otherwise would get into the machines and on to the windings is eliminated—a favorable factor in the equipment's maintenance. The incoming air can be delivered at the machines, consequently they will operate at a considerably lower temperature than with natural ventilation. Lower winding temperatures mean lower power losses and decreased insulation deterioration.

Where the cars are stopped level at the floors automatically the control will function more accurately, if the temperature of the windings is kept within conserva-

tive limits. This is desirable even when manual leveling is used, since keeping down leveling operations saves power consumption and equipment wear and tear.

For large electric-power machines it has been found economical to use artificial ventilation even when natural means could be used. A careful study might show the same to be true for elevator equipment. The temperature of some elevator motors operating with artificial ventilation would seem to indicate that their dimensions could be reduced considerably without impairing operation. This problem is comparatively new, also complex; but it offers a fruitful field for study by building and machinery designers to develop a combination of elevator equipment that will be the most economical when all factors of first cost, operation, maintenance and service are considered.

## Engineering Union Establishes Age Limit

LABOR ORGANIZATIONS, who in the past have fought strenuously against the establishment of an age limit by industry, apparently are preparing to adopt industry's viewpoint. As evidence of this shift in policy may be cited the decision of the International Union of Operating Engineers to refuse membership to engineers over fifty-five years of age.

The argument advanced by the Union's president is that an engineer, however old, immediately upon receiving a membership card becomes entitled to all the benefits of the Union's death fund. The probable amount collected from a man over fifty-five is so small that his portion of the death fund will not be self-supporting. Old age or pre-deathbed repentance is not favored by the Union's president, who caustically comments that "if these men have been working as engineers all their lives they should have joined the union long before they reached this age."

While industry's attitude has been attributed by many to a disinclination to endure the drop in output age sometimes brings with it, actually old age pension and death benefit systems are the basic reasons for the policy. A man is not entitled to such benefits if he enters a firm's employ late in life; so such benefit systems are, in a measure, industry's reward to the faithful workman, a bonus for past performance.

Both the Engineers' Union and industry can avoid setting up an age limit by rearranging the benefit funds in such a way that a man draws out an amount in proportion to his length of service.

Labor unions would do well to think twice before refusing membership to older men, although it may not include old age benefits. With industry setting up an age bar, the old workman is entitled to expect a little sympathy and brotherhood feeling from fellow workmen, even if during his younger days he may have remained outside in the darkness.

## The Parsons Line

WHEN the coal consumption of a station over a definite period is plotted against the net kilowatt output the resulting graph generally approximates a straight line. This curve is known by many as the "Parsons line" and in some stations is used as a measure of station performance. Undoubtedly such a line, based on actual operation, forms a good bogey by which to gage future results.

Some have drawn a straight line through the plotted points. When this is extended back to zero station output, it gives a fuel consumption often regarded as the actual no-load or stand-by losses of the plant. The formula for such a line has been offered as a measure of power station performance. It will be obvious that this is not a satisfactory unit, because various stations require different stand-by equipment. Furthermore, the use-factor of the station is not considered.

Among the many variables entering into station performance are these stand-by and no-load losses, the use-factor of the station, the variations in the temperature of the cooling water, and the peak load which the equipment must be prepared to carry each day. The individual units, such as boilers and turbines, also vary in performance, depending upon the particular loads they are required to carry and their individual efficiencies. Thus a formula designed to measure steam station performance under a variety of conditions must consider such variable factors. As a result it may become so complex that its usefulness is limited.

The corresponding Parsons line in such a case may not be exactly straight. Yet it would be very helpful to an operating engineer if he could find values for all the variables in his plant and could so combine these as to be able to predict a Parsons line for any given set of conditions. This would set a standard with which actual performance could be compared. The problem, therefore, is to develop a method of analyzing these variables and of deriving an expression to use them as a measure of performance. Here is a job for engineers analytically inclined.

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## POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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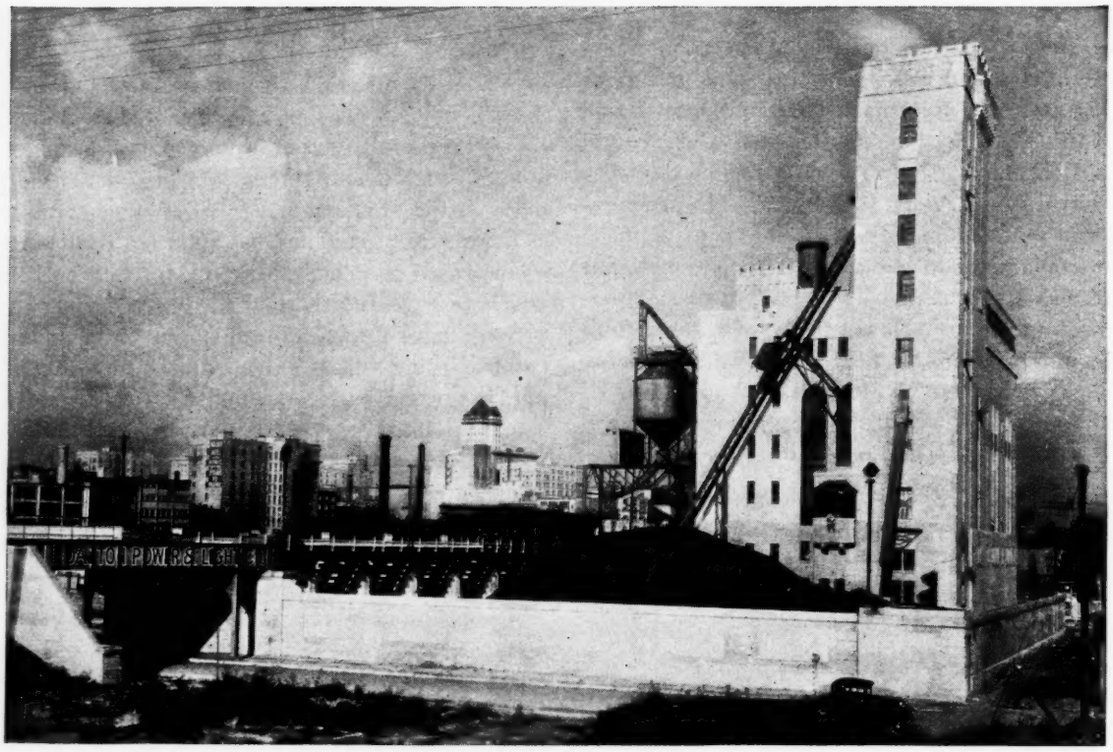


Longworth central heating plant, showing coal- and ash-handling system. The tower contains the feed-water tank

# Dayton Adds to Central Heating

By J. G. BUTTERWORTH
*Columbia Engineering & Management Corp.*

**NEW CENTRAL HEATING PLANT is equipped with underfeed-stoker-fired boiler using combustion air preheated to 390 deg. Well water for boiler feed is treated in a lime-and-soda hot-process system supplemented by phosphate. Skip hoist and tram car handle coal. Dump cars and skip hoist dispose of the ash**

DAYTON, OHIO, has had a district heating system since 1908. It has expanded until at the present time there is only one major building in the heating district not heated by steam supplied by the Dayton Power & Light Company. With a system sixth largest in the country on the basis of maximum demand, the records also show that Dayton ranks fifth in the number of steam customers and fourth in volume of seasonal send-out. Steam has been supplied by two plants—the Third Street and the Fourth Street stations. As both are in the eastern section of the heating district, it was desirable to build the new plant in the southwest extremity at Longworth and Eaker Streets, a site having ample room for expansion, space for coal storage and adjoining the Pennsylvania Railroad.

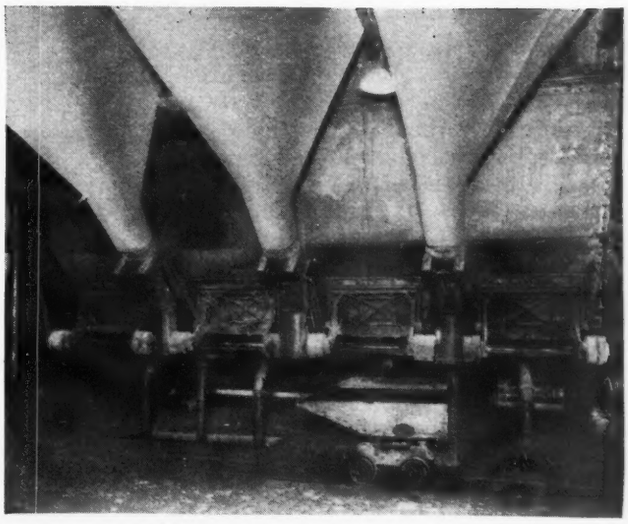
Consideration was given to high-pressure boiler equipment with a non-condensing turbine to supply exhaust steam to the heating system; but, as the load factor of the heating-system requirements would permit the operation of the turbine only five months per year, the return on the added investment was not sufficient to cover the fixed charges.

In designing the new plant, simplicity of operation and reliability of service were foremost. The low load factor of the heating system necessitated holding the initial cost and the labor to a minimum. The present building is designed for two boilers, with provision for two additional units.

The initial installation consists of one Stirling-type boiler operating at 225 lb. with water-cooled bridge wall and tubular-type air preheater. Water-treating and coal- and ash-handling systems are installed to serve four boilers. The side walls along the stoker are lined with silicon carbide air-cooled blocks. A few feet above the blocks is a side-wall supporting beam with suspended-wall construction. The setting is designed throughout

to operate with a boiler output of 150,000 lb. per hour. The underfeed stoker has 11 retorts and 41 tuyères, and double 18-in. crusher rolls. It is driven by either steam turbine or an electric motor. The crusher rolls are driven by oil-operated pistons, the oil pressure supplied from a motor-driven Hele-Shaw pump. Air is preheated to 390 degrees.

**Discharge from the ash hoppers is into 18-cu.ft. dump cars operating on a track leading to a skip hoist**



In certain respects coal and ash handling is out of the ordinary. The coal is discharged from cars to a hopper suspended from the trestle supporting the railway track serving the plant. Transfer is made to a 100-ton per hour skip bucket which elevates the coal to a hopper at the top of the coal tower. From this hopper the coal drops to a shaking screen and then into another hopper directly above a tram car track. This latter hopper is fitted with gates which are opened by the tram car passing under and are closed as the tram car moves away.

Movement of the tram car is synchronized with the movement of the skip bucket, so that when the skip bucket is returning to the track hopper the tram car is passing out over the 840-ton suspended bunker.

Coal for outdoor storage bypasses the shaking screen and is discharged through a chute to the storage yard to form a pile for a drag scraper. In the yard 7,500 tons of coal can be stored and reclaimed to the track hopper by an apron feeder. Both the forced- and the induced-

## Equipment of Longworth Steam Station

### Boiler and Air Heater

Boiler, Stirling, 15,253 sq.ft., 250 lb. of press., Babcock & Wilcox Co.
Air heater, tubular, 12,360 sq.ft., air 80 to 398 deg., Babcock & Wilcox Co.
Soot blower units, 15, Diamond "valve-in-head," Diamond Power Spec. Corp.
Safety valves, five 4½ in. Consolidated, Ashcroft, Hancock Co.
Water columns, Stirling, high and low alarm, Babcock & Wilcox Co.
Gage glasses, Sesure inclined ..... Yarnall-Waring Co.
Gage, steam pressure, 12-in. Ashcroft, Consolidated, Ashcroft, Hancock Co.
Valves, 2, stop and check, 4-in. feed. Babcock & Wilcox Co.
Valves, 4, blowoff, Everlasting, Straightway, Everlasting Valve Co.
Stop valve, 10-in. non-return ..... Foster Wheeler Corp.

### Stoker and Furnace

Stoker, Taylor underfeed, 11-retort, 41 tuyère, 334.9 sq.ft. proj. area; motor and turbine drive; 18-in. double crusher rolls driven by Hele-Shaw pump ..... American Eng. Co.
Bridgewall, Bailey water-cooled, 238 sq.ft. Fuller Lehigh Co.
Sidewalls, arches ..... M. H. Detrick Co.
Baffles ..... Power Plant Efficiency Co.
Blocks, silicon carbide, air-cooled, Drake Non-Clinkering Furnace Block Co.
Firebrick ..... The Chas. Taylor Sons Co.
Boiler brickwork ..... Geo. Allen & Son

### Draft Equipment

Fan, induced-draft, cinder eliminating, 120,000 c.f.m., 505 deg., 7-in. stat. press.; drive 257-hp. Terry turbine 730 r.p.m. ..... Buffalo Forge Co.
Fan, forced-draft, 60,000 c.f.m., 80 deg., 9 in. stat. press.; drive 125-hp. Terry turbine, 1,175 r.p.m. Buffalo Forge Co.
Furnace, draft control, aut. constant ..... Bailey Meter Co.

### Boiler Feed

Pump, 3-stage, 400 g.p.m., 680-ft. head; drive 138-hp. Terry turbine, 2,850 r.p.m. ..... Platt Iron Works
Pump, 4-stage, 400 g.p.m., 680-ft. head; drive 150-hp. Westinghouse ind. motor, 1,750 r.p.m. ..... Platt Iron Works
Feed-water regulators, Copes, two 4-in., Northern Equipment Co.
Pump governor 2½ in. ..... Bailey Meter Co.

### Water Treating and Supply

Pumps, 2 deepwell, 3-stage, 820 and 1,025 g.p.m.; drives 60- and 75-hp. Westinghouse, 220-volt motors, 1,760 r.p.m. ..... Ponoma Pump Co.
Storage tank, 100,000 gal. ..... Chicago Bridge & Iron Co.
Water-softening plant, hot process, lime and soda ash supplemented with di-sodium phosphate, 70,000 gal. per hr.; equipment: 3 chemical mixing tanks; 2 proportioners, 40,000 gal. per hr. each; 2 open heaters with vent condensers; one 70,000-gal. precipitating tank; 2 sand filters, 8 ft. dia. 20 ft. long ..... Power Plant Specialty Co.

### Coal Handling

Capacity of system, 100 tons per hour; equipment: one 120-cu.ft. skip hoist, one vibrating screen, one 120-cu.ft. tram car, one 840-ton suspended steel bunker, one 115-ton per hour drag scraper with reclaiming hopper and apron conveyor; drives, General Electric slip-ring and ind. motors, 40, 7½ and 60 hp. ..... R. H. Beaumont Co.

### Ash Handling

Capacity of system, 25 tons per hour; equipment: two 18-cu.ft. dump cars; one 40-cu.ft. skip hoist and 20-hp. G.E. ind. motor; one 5,000-cu.ft. ash bunker, R. H. Beaumont Co.

### Meters and Instruments

One boiler panel, including boiler meter, multipointer draft gage, temperature recorder, draft control. Bailey Meter Co.
One general panel, including flow meters, temperature and pressure recorders, tank level recorder. Bailey Meter Co.
Master gages, 2 ..... Ashton Valve Co.
Recorder, Ranarex $CO_2$ ..... Permutit Co.

### Valves and Piping

Valves, in general ..... Chapman Valve Mfg. Co.
Valves, miscellaneous ..... Lunkenheimer Co.
Valves, check ..... Golden-Anderson Valve Spec. Co.
Valves, chronometer ..... Schutte-Koerting Co.
Valves, back-pressure ..... Cochrane Corp.
Valves, reducing ..... Foster Wheeler Corp.
Expansion joints ..... J. S. Kopperman & Sons
Pipe, fabricated ..... { Walworth Co. / Pittsburgh Piping & Equip. Co.
Pipe, cast-iron ..... U. S. Pipe & Foundry Co.
Insulation ..... Philip Carey Co.

### Miscellaneous

Air compressor, hor. duplex, 300 c.f.m.; 110 lb. press.; belt drive by 60-hp. Westinghouse ind. motor, 1,160 r.p.m., Worthington Pump & Mach. Corp.
Sump pump, duplex, 100-ft. head, 150 g.p.m.; drive 2 G.E. 10-hp. motors, 1,750 r.p.m. ..... Yeomans Bros.
Sump pump, duplex, 30-ft. head, 150 g.p.m.; drive, two 1½-hp. G.E. motors ..... Yeomans Bros.
Elevator, Microdrive, aut. push button, 4,000 lb., Otis Elevator Co.
Car spotter, Caldwell motor-driven ..... Link Belt Co.
Blowoff tank, stacks and ducts ..... Graves & Marshall Co.
Oil storage ..... S. F. Bowser & Co.
Unit heaters, 4 ..... Buffalo Forge Co.
Warehouse scale ..... Fairbanks Morse & Co.

### Electrical Equipment

Main power and light distributing switchboard, I.T.E. Circuit Breaker Co.
Light and power branch distributing cabinets, Powerlite Switchboard Co.
Auto-transformers, 450 kva. ..... General Electric Co.
Power transformers, 450 kva. Westinghouse Elec. & Mfg. Co.
Electrical installation work ..... Lesher Electric Co.

draft fans are turbine-driven. The former is of the cinder-eliminating type. Automatic control has been provided for the throttle valve of the turbine driving the induced-draft fan, and the turbine of the forced-draft fan has a motor-operated valve remotely controlled from the boiler panel board.

Beneath the stoker a vitrified brick-lined ash hopper is fitted with manually-operated pivoted gates. Connections are made with the soot hopper in the boiler and the hopper under the cinder-eliminating fan. These connections have gates which are automatically opened by the weight of the cinders. Discharge from the ash hopper is into 18-cu.ft. dump cars operating on a track of 24-in. gage leading to an ash skip hoist. The latter discharges into a tank mounted above the railroad track, arranged for spouting to either trucks or railroad cars.

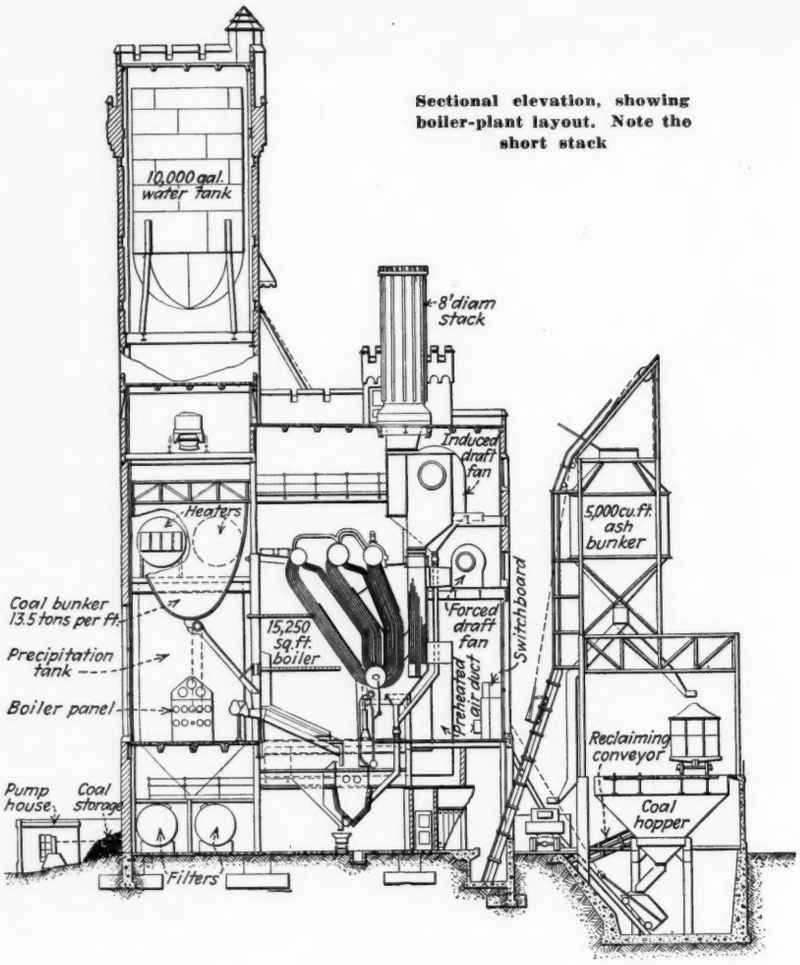
Feed water is obtained from two wells having cast sectional concrete casings. The water is pumped to a 100,000-gal. storage tank in the tower by deepwell pumps started and stopped automatically by the water level in the tank.

Water from the overhead tank passes through piston meters, which operate chemical pumps, to the tray-type heaters used in connection with the lime-and-soda hot-process water-treating system. The heaters are fitted with vent condensers and are mounted on the sedimentation tank, from which the water flows through two filters to the suction header of the boiler-feed pumps.

Three mixing tanks are provided for the lime, soda and phosphate treatment, and a platform scale for weighing the chemicals. It was found necessary to install a surface, continuous blowdown system to maintain the proper concentration. For reasons of heat balance, one of the two 400-g.p.m. boiler-feed pumps is turbine-driven.

A 16-in. line 2,700 ft. long connects the boiler plant with the distribution system. At the junction oint there is installed an underground vault where a reducing valve lowers the pressure to 90 lb. for the medium-pressure system. Steam is also bled into the low-pressure system through a motor-operated valve controlled from the boiler plant. The line is welded throughout and has corrugated copper expansion joints. The insulation consists of 2 in. of "Multiply" with a 30-lb. fiber-rock jacket.

The pipe is in a conduit made up of a concrete slab for the bottom, terra cotta hollow tile sides and a reinforced concrete top.




**Sectional elevation, showing boiler-plant layout. Note the short stack**

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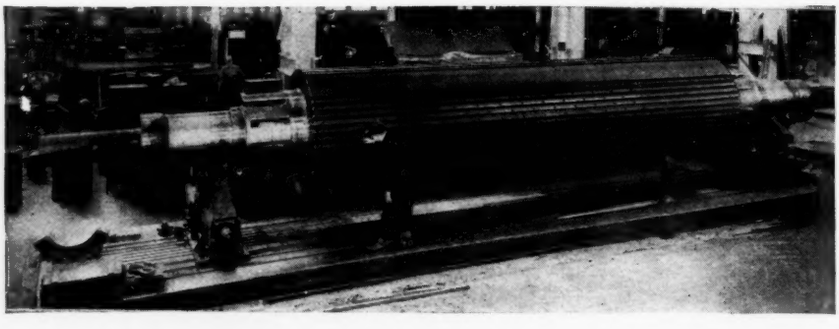
# MACHINING ROTOR FOR 160,000 KW. UNIT



**The photograph shows the partly machined rotor forging for a 160,000-kw., 200,000-kva. turbine-generator, two of which are under construction at the Schenectady works of the General Electric Company for the Brooklyn Edison Company.**

# Soldering to Make Good Electrical Connections

By WILLIAM BUTTERS
*Irvington, Calif.*

SOLDER is a fusible metallic cement. Usually the compound used to solder electrical conductors is composed of tin and lead. An alloy of 42 per cent tin and 58 lead is widely utilized, but other percentages give good results. A composition of one-half tin and one-half lead is also used for general soldering. For wiping joints in lead cable sheaths an alloy of one-third tin and two-thirds lead is generally used. The per cent composition of solders approved by the N.E.L.A. is:

| | For Connections | For Wiping |
|---|---|---|
| Tin | 50 | 40 |
| Lead (approx.) | 50 | 60 |
| Antimony (max.) | 0.12 | 0.12 |

Tin-lead alloys begin to soften at 183 deg. C., but the temperature required to cause complete fluidity depends upon the percentages of tin and lead. With an alloy of 62 per cent tin and 38 per cent lead the temperature of complete fluidity is a minimum, 183 deg. C. It increases from this value if the lead content is either increased or decreased.

Pure tin has a melting point of 232 deg. C. and sometimes is used as solder. Its cost, which is about four times that of lead, and the fact that its melting point is not much higher than that of a cheaper tin-lead alloy, is the principal reason why tin is not commonly used as solder. Tin flows freely and readily eats into copper.

Pure lead has a melting point 326 deg. C., but is not satisfactory for soldering. It will not flow readily, will not hold, and the heat required to work it is likely to oxidize the surfaces to be soldered.

Generally, metals, including tin and lead, flow freely when melted, and solidify quickly with a relatively small decrease in temperature, thus making soldering difficult. On the other hand, alloys, when cooling usually pass through a range of gradually decreasing fluidity, which is helpful in most soldering operations.

A high-temperature solder, melting point 300 deg. C., developed by one of the large electrical manufacturing companies, has proved valuable for certain applications, such as on commutators. The composition of this solder is given, in percentages, as silver, 2.5; copper, 0.25; and lead, 97.25. For most purposes the ordinary tin-lead solder is satisfactory, but a high-temperature solder should be employed if high temperatures are likely to be encountered.

When solder is overheated a yellow crust, or blanket, forms which excludes air, thus retarding further oxidization. If this crust is removed when the temperature of the solder has decreased to the proper working value the addition of a little tin, with thorough stirring, will restore the solder's original qualities.

Soft solder becomes useless by the gradual accumulation of various oxides, zinc, iron and brass filings. To purify solder that has been so contaminated heat it to 425 deg. C. (dull red in the dark) and throw in sulphur. Stir the solder well, avoiding the fumes, which are highly irritating. The sulphur combines with the zinc and brings it to the surface. Other oxides will rise, or cling to the surfaces of the melting pot. Thoroughly skim the solder, removing the crust entire, if possible. Cool to working temperature (about 245 deg. C.), and stir in a little tallow. The tallow will remove the last of the sulphur and the solder will be clean. A little pure tin should be added to compensate for that burned away.

Soldering flux is employed to prevent oxidization or to dissolve any oxide formed while the parts are being brought to the soldering temperature. It is made in liquid, paste or solid forms. The most important requirement of a soldering flux for electrical conductors is that it be non-corrosive, otherwise the connection will ultimately fail due to excessive heating. So many satisfactory fluxes in paste, solid and liquid form are on the market that it is rarely worth while to prepare them.

Applying a coating of solder is known as tinning. Since solder will not corrode in the atmosphere it is common practice to tin lugs and connectors and the surfaces of conductors that make contact.

### Conductivity of Solder

The conductivity of solder is approximately one-seventh that of copper. This is of little consequence so far as well-made splices are concerned, because the object of soldering a splice is to prevent corrosion and its destructive effects. But in soldering lugs on conductors the solder is generally required to transmit all of the current that passes from the lug to the conductor, the conductor rarely being in intimate contact with the sides or bottom of the lug. If the depth of the lug is approximately twice its diameter, the area of the solder will be sufficient to prevent overheating.

Open-flame torches burning gasoline, acetylene gas or alcohol are used to heat parts to be soldered directly, or through the medium of a soldering copper. Melting pots are heated by either gasoline, gas or electricity, the latter being best. When acetylene gas is used the burner is generally attached to a full container. Empty containers are refilled. Illuminating gas is sometimes used.

Soldering coppers, incorrectly termed soldering irons, are made in a wide range of weights. For most work a square-pointed tip is satisfactory, but in some cases the tip should be made to suit the job. Soldering small splices is greatly facilitated by cutting a V-shaped groove near the tip of the soldering copper. Such a groove serves as a small trough.

Soldering coppers are often electrically heated, and this method is quite effective. However, when used on heavy work electrically heated coppers are likely to cool too quickly. This limitation can be removed. It would appear that a soldering copper having its temperature controlled by a thermostat would be ideal.

The tip of a soldering copper must be kept well tinned

to obtain good results. An excessive temperature will burn away the coating of solder and roughen the surfaces. A soldering copper can be kept well-tinned by wiping its tip, while hot, over a block of sal-ammoniac sprinkled with a few drops of solder. The tip can be kept clean, if not burned, by occasionally plunging it into a saturated solution of sal-ammoniac and water.

The method of heating connections by current at low voltage flowing between carbon electrodes, as described in *Power*, May 13, 1930, page 753, is very effective, especially for shop work. The connections of the first generators installed at Niagara Falls were soldered by a method similar to that described in the article mentioned.

If, before soldering, the separate parts are well tinned good results are assured. Tinning is done by first carefully cleaning, applying a flux, then heating until the solder flows freely. Excess solder should be wiped off, using a clean cloth. The plating of solder should be thin and smooth. Good results are obtained on parts like lugs and the ends of conductors by first dipping in flux, then submerging in a pot of solder that is maintained at a temperature that will char but not burn newspaper. Excess solder will drip from the parts. Tinning may also be done by pouring solder over the parts, care being taken to keep the solder hot. Cleaning is done by filing, scraping, using sandpaper or emery cloth, or a wire brush.

### Soldering Lugs on Conductors

Lugs should always be tinned on the inside, and the conductors to be soldered therein should also be thoroughly tinned. If it is desired to keep the exterior of the lug free of solder it may be wrapped with one layer, half-lapped, of ordinary friction tape. The friction tape may burn away, but the residue, which can be easily removed with gasoline, will prevent the solder from sticking. Or plumber's paste, which is made by mixing flour and water and adding a little alum to prevent the mixture from spoiling, may be applied. This may be removed with water. On some work, such as splicing a lead cable sheath, glued paper may be used to keep the surface free of solder.

Occasionally it is necessary, as when a conductor cannot be bent, to solder a lug with the open end down. In this case one $\frac{3}{16}$-in. or two $\frac{5}{32}$-in. holes are drilled in the closed end (bottom) of the lug. It is tinned and taped to the conductor, using friction tape, in such manner that the solder cannot escape. The lug is then heated and flux applied through the hole followed by wire solder when hot enough. Solder is fed in until all flux is forced out and solder appears. The lug is then cooled slightly and enough solder is added to rise somewhat above the surface of the copper. After cooling the projecting solder is smoothed off with a fine file. Care must first be taken to secure the lug in the proper position, for this method of soldering will stiffen a stranded conductor.

As before stated, splices are required to be so well made that the only object of soldering is to prevent corrosion of the copper. A perfect splice should be tinned rather than soldered. Many electrical workers, however, prefer to fill a splice with solder. This is accomplished by first thoroughly tinning the completed splice, then, as the splice cools, adding sufficient solder to fill all interstices. It may be necessary to heat and cool the splice repeatedly to cause sufficient solder to adhere thereto. Excess solder is wiped off while plastic.

# Load Division By the Increment Method

By GORDON R. HAHN

When two or more machines, turbines or boilers are operated in parallel or supply a single source of power or steam, it is logical to apportion the division of load in such a way that the ratio of output to input is a maximum. Many methods have been devised to obtain this end, one of which is the increment method.

After a certain output has been established, this method of load division, requires that the next unit of load be picked up on the machine demanding the least increase in input to deliver the necessary increase in output. Thus, the load is increased on the machine on which the ratio of increase in input to increase in output is a minimum. When increasing the load this ratio, called the increment rate, should be kept the same for all machines on the line or bus. If both input and output are expressed in the same units the increment rate is equal to the slope of the input-output curve. In case the input and output are not in the same units a ratio will be obtained that is proportional to the slope. Any units may be used as long as the same units are used for all machines.

To use this method of loading, curves must be plotted for all machines showing the variation of increment rate with load. The maximum combined efficiency will be obtained for any load when the increment rates are the same for all machines.

To construct the required increment-rate curves it is necessary to have or secure data which show efficiency or input and output at various loads. Assume that curves $L$ and $S$ are the required data for a large and a small turbine-generator having different heat rates and that both machines are to supply a common load.

It will be convenient to prepare a table for each machine similar to Tables I and II. Column 3 of these tables is the total heat consumption and is equal to the product of Column 1 times Column 2. Column 4 is the change in total heat consumption between two adjacent units of load. For example, the increase in heat consumption from a load of 1,900 kw. to a load of 2,000 kw. is $(41.4 - 39.0) \times 10^6$ B.t.u. $= 2.4 \times 10^6$ B.t.u. Column 5 is the increment rate and is equal to the change in input, Column 4, divided by the increment load, 100 kw. in this case.

Curves $L_1$ and $S_1$ show the increment rates for the large and small machines. It might be stated here that

TABLE I—HEAT CONSUMPTION, LARGE MACHINE

| Load Kw. | B.t.u. Per Kw.-hr. | B.t.u.x $10^6$ | Change In B.t.u.x $10^6$ | Increment Rate | Load Against Which Inc. Rate Is Plotted |
|---|---|---|---|---|---|
| 2,000 | 20,700 | 41.4 | 2.4 | 0.0024 | 1,950 |
| 1,900 | 20,500 | 39.0 | 2.3 | 0.0023 | 1,850 |
| 1,800 | 20,400 | 36.7 | 2.2 | 0.0022 | 1,750 |
| 1,700 | 20,300 | 34.5 | 2.2 | 0.0022 | 1,650 |
| 1,600 | 20,200 | 32.3 | 2.2 | 0.0022 | 1,550 |
| 1,500 | 20,100 | 30.1 | 2.1 | 0.0021 | 1,450 |
| 1,400 | 20,000 | 28.0 | 2.0 | 0.0020 | 1,350 |
| 1,300 | 20,000 | 26.0 | 1.9 | 0.0019 | 1,250 |
| 1,200 | 20,100 | 24.1 | 1.9 | 0.0019 | 1,150 |
| 1,100 | 20,200 | 22.2 | 1.8 | 0.0018 | 1,050 |
| 1,000 | 20,400 | 20.4 | 1.7 | 0.0017 | 950 |
| 900 | 20,800 | 18.7 | 1.7 | 0.0017 | 850 |
| 800 | 21,200 | 17.0 | 1.8 | 0.0018 | 750 |
| 700 | 21,700 | 15.2 | 1.9 | 0.0019 | 650 |
| 600 | 22,200 | 13.3 | 1.9 | 0.0019 | 550 |
| 500 | 22,800 | 11.4 | 2.0 | 0.0020 | 450 |
| 400 | 23,400 | 9.4 | 2.1 | 0.0021 | 350 |
| 300 | 24,200 | 7.3 | 2.1 | 0.0021 | 250 |
| 200 | 25,100 | 5.2 | .... | ..... | .... |

the use of these curves will show how to obtain minimum total heat consumption only when both machines are in operation. Consider a load of 2,000 kw. If *L* machine only is on the bus (possible but not probable) the heat consumption per hour will be $2{,}000 \times 20{,}700 = 41.4 \times 10^6$ B.t.u. If both machines are on, at an increment rate of 0.0020, the loads will be 1,350 and 650 kw., respectively, on the large and small units. This gives a total heat requirement of $1{,}350 \times 20.0 \times 10^3 + 650 \times 22.65 \times 10^3 = 41.7 \times 10^6$ B.t.u. which is greater than the heat consumption with only the large unit on the line. Hence the above statement that this method of loading gives total minimum heat consumption only when both machines are on.

TABLE II—HEAT CONSUMPTION, SMALL MACHINE

| Load Kw. | B.t.u. Per Kw.-Hr. | B.t.u.x $10^6$ | Change In B.t.u.x $10^6$ | Increment Rate | Load Against Which Inc. Rate Is Plotted |
|---|---|---|---|---|---|
| 1,600 | 23,200 | 37.1 | 2.9 | 0.0029 | 1,550 |
| 1,500 | 22,800 | 34.2 | 2.8 | 0.0028 | 1,450 |
| 1,400 | 22,400 | 31.4 | 2.6 | 0.0026 | 1,350 |
| 1,300 | 22,200 | 28.8 | 2.4 | 0.0024 | 1,250 |
| 1,200 | 22,000 | 26.4 | 2.3 | 0.0023 | 1,150 |
| 1,100 | 21,900 | 24.1 | 2.2 | 0.0022 | 1,050 |
| 1,000 | 21,900 | 21.9 | 2.1 | 0.0021 | 950 |
| 900 | 22,000 | 19.8 | 2.1 | 0.0021 | 850 |
| 800 | 22,200 | 17.7 | 2.0 | 0.0020 | 750 |
| 700 | 22,400 | 15.7 | 2.0 | 0.0020 | 650 |
| 600 | 22,900 | 13.7 | 2.0 | 0.0020 | 550 |
| 500 | 23,400 | 11.7 | 2.0 | 0.0020 | 450 |
| 400 | 24,200 | 9.7 | 2.1 | 0.0021 | 350 |
| 300 | 25,200 | 7.6 | 2.2 | 0.0022 | 250 |
| 200 | 27,000 | 5.4 | .... | ..... | .... |

Let us now consider various loads on the station and show that the curves give minimum heat consumption. Under each of the total loads in Table III the increment rate loading heat consumption is given first and underneath various other loadings are shown.

The last column of Table III, giving total heat consumption, shows that in all cases taken that the apportionment of load based on the increment rate method requires the least heat consumption to deliver the total load.

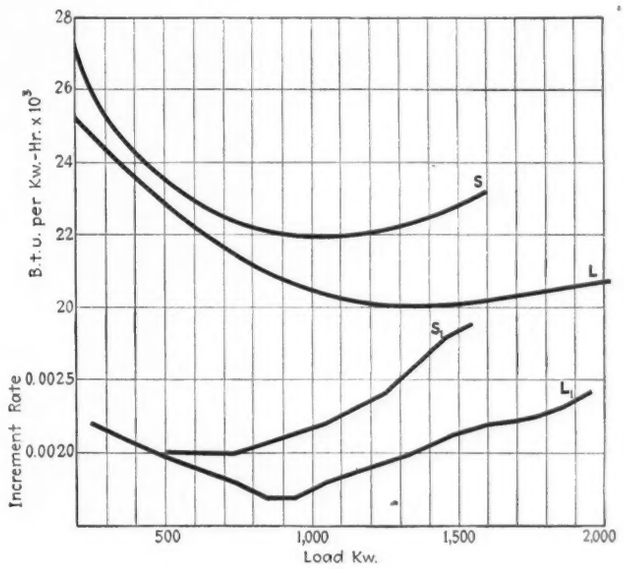
TABLE III—TOTAL HEAT CONSUMPTION, TWO UNITS OPERATING

| Total Load Kw. | Large Machine: Load | Large Machine: Heat Rate $10^3$ B.t.u. | Large Machine: Heat Consumption $10^6$ B.t.u. | Small Machine: Load | Small Machine: Heat Rate $10^3$ B.t.u. | Small Machine: Heat Consumption $10^6$ B.t.u. | Total Heat Consumption |
|---|---|---|---|---|---|---|---|
| 1,900 kw. | | | | | | | |
| Increment Method | 1,350 | 20.0 | 27.0 | 550 | 23.2 | 12.7 | 39.7 |
| Alternate Method | 1,500 | 20.1 | 30.1 | 400 | 24.2 | 9.7 | 39.8 |
| Alternate Method | 1,200 | 20.1 | 24.1 | 700 | 22.4 | 15.7 | 39.8 |
| Alternate Method | 1,700 | 20.3 | 34.5 | 200 | 27.0 | 5.4 | 39.9 |
| 2,200 kw. | | | | | | | |
| Increment Method | 1,400 | 20.0 | 28.0 | 800 | 22.2 | 17.7 | 45.7 |
| Alternate Method | 1,600 | 20.2 | 32.3 | 600 | 22.9 | 13.7 | 46.0 |
| Alternate Method | 1,200 | 20.1 | 24.1 | 1,000 | 21.9 | 21.9 | 46.0 |
| Alternat Method | 2,000 | 20.7 | 41.4 | 200 | 27.0 | 5.4 | 46.8 |
| 2,500 kw. | | | | | | | |
| Increment Method | 1,550 | 20.1 | 31.2 | 950 | 21.95 | 20.8 | 52.0 |
| Alternate Method | 1,700 | 20.3 | 34.5 | 800 | 22.2 | 17.7 | 52.2 |
| Alternate Method | 1,400 | 20.0 | 28.0 | 1,100 | 21.9 | 24.1 | 52.1 |
| Alternate Method | 2,000 | 20.7 | 41.4 | 500 | 23.4 | 11.7 | 53.1 |

Further study of the increment rate curves shows that when both machines are on the line the minimum load on the large unit will be 1,350 kw. Load will then be picked up on the small machine until its load is 750 kw. Then the output will be increased progressively on both machines, keeping their increment rates at the same value until full load is reached on the large unit. Further increase must then be handled by the small machine.

It should be remembered that the division of load by this method gives results that are only theoretically correct and does not take into consideration other than ideal machine conditions.

Load division using increment rates may be applied to any parallel operation of units such as boilers, turbines, motor-generators, etc. In some cases, certain corrections must be applied to the input-output curves before the increment rates are determined. In the case of boilers, corrections such as different coal costs or difference in coal preparation costs, superheat other than normal and cost of operating boiler auxiliaries must be considered. Turbine input-output curves must be corrected for vacuum and superheat, because these factors affect input.




**Heat consumption and increment rate curves for large and small turbine generator**

Increment-rate curves may be difficult and costly to prepare due to the testing required to obtain data, but such a considerable saving may be effected by their use that the difficulty and cost are well worth while.

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## Cambridge Plant Has Smoke Eye

THE NEW OIL-BURNING BOILER at the Simplex Wire & Cable Company plant at Cambridge, Mass., is equipped with an automatic smoke-indicating device consisting of an electronic, or photo-electric, cell to which is directed a beam of light from a steady source. The relative amount of brightness in the flue is thus automatically indicated on the scale of an ammeter calibrated to read directly in units corresponding to standard smoke charts. Any condition of smoke above the safe limit makes automatic contact with a bell circuit in addition to the instrument indication. This "smoke eye" was installed by the Acme Apparatus Company.

The location of the cell and light source across the flue under the boiler house roof permits easy cleaning and general maintenance without the necessity of climbing around the stack above the roof outdoors. The indicating instrument and alarm bell are located at the operator's panel at the boiler front.

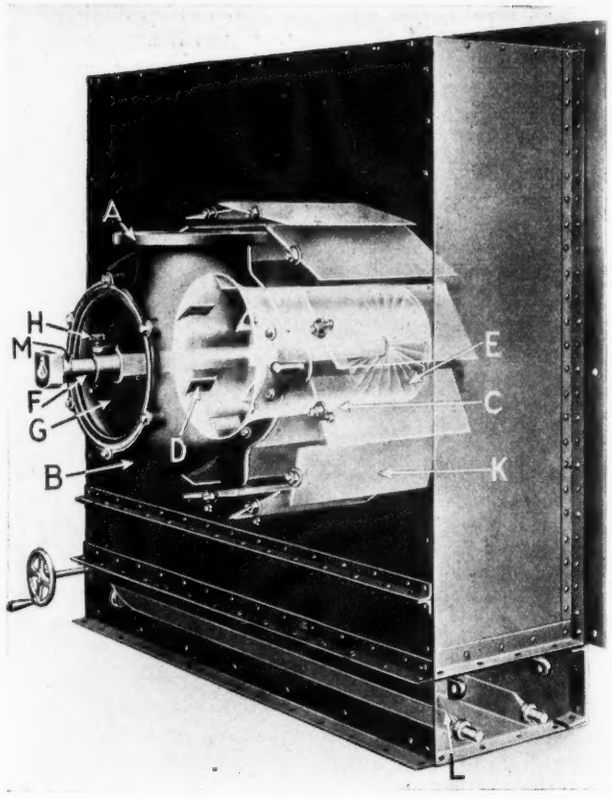


**Fig. 1—Flare-type pulverized-coal burner used at the New Yorker. Gas burner is inserted through tube *F***

# Lighting Pulverized Coal With Gas

## A description of the system used in the New Yorker Hotel

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THE INITIAL LIGHTING of a pulverized-coal furnace must, of necessity, be by some outside fuel. Kerosene torches or oil burners are often used, but it has been found that gas is more positive and efficient. In New York City the gas company had an excellent opportunity to apply gas for lighting the battery of pulverized-coal-fired boilers installed at the New Yorker Hotel. This battery comprises four 6,500-sq.ft. horizontal water-tube boilers, operating at 200 per cent rating and 125 lb. steam pressure. Steam is delivered to the hotel electric generating plant, the exhaust being used for heating and other miscellaneous purposes.

### New Yorker's Firing System

Each boiler is fired by a Riley flare-type pulverized-coal burner having a capacity for 6,000 lb. of coal per hour. Natural draft of one-half inch of water is produced by an inside stack extending above the top of this 44-store hotel. Pulverized coal is carried to the burner and delivered in an air stream moving at 3,000 ft. per minute.

Before discussing the gas-igniting system the operation of the coal burner will be briefly described. Pulverized coal, carried in suspension by primary or conveying air, enters chamber *B* (Fig. 1) through flanged connection *A*. The stream is given a circular motion within the chamber and enters pipe *C* while revolving about the axis of the pipe. Since this motion tends to cause the coal stream to travel along the wall of the pipe, vanes *D* are arranged to divert the stream toward the center.

The coal then passes to the tip of the pipe, completely filling the space between pipes *F* and *C*. Vanes *E* break the stream into a number of streams and divert these into a conical flare.

Secondary air, supplied under pressure from a fan, passes dampers *L*, which control the quantity of air flowing, and is given a whirling motion in passing between vanes *K*. The amount of whirl is determined by the angular position of these vanes. In general, the direction of rotation of the secondary air is opposite to that of the primary air and coal in the chamber *B* and pipe *C*.

Mixing of secondary air with primary air and coal occurs beyond the tip of burner *E*. The coal stream issuing from tip *E* in the form of a flare is violently whipped by the stream of secondary air issuing through vanes *K*, the two streams being in rapid and opposite rotation.

Impingement of coal stream on vanes *E* results in strata consisting of alternate rich and lean mixtures of coal and air. The rich portions of the stream ignite readily and act as kindling to the remainder.

### Gas Lighting System

Initial lighting is accomplished by a high-pressure gas burner having a capacity of 450 cu.ft. of gas per hour. A flexible hose connection is made between the main gas header and a 1½-in. manifold 40 in. long, at the end of which is fashioned a slotted burner. This manifold with burner nozzle at its end is inserted in tube *F*, the nozzle extending just past the edge of the coal burner. A fan-like flame is produced at the mouth of the coal burner, burning at right angles to the flow of coal. The flame being directly in the path of the coal, ignition is practically instantaneous. On lighting,

only primary air is admitted with the coal. Later dampers *L* are gradually opened until the amount of secondary air is correct for the amount of coal being burned. In this way, with the rich mixture at the start, no serious explosions are encountered.

The coal flame is adjusted by advancing or retarding pipe *F* and rosette *E*. With the rosette advanced beyond the end of pipe *C* the flare will be the greatest. With the rosette drawn entirely within the pipe the flare will be the least.

### Booster for Gas Pressure

High-pressure gas is supplied by a rotary booster pump delivering up to 1,200 cu.ft. per hour at 4-lb. pressure. This booster delivers the gas to a main header from which a flexible connection can be made at each boiler station. It is a rotary-type compressor, air cooled with pressure oil system, and bypass relief valve for pressure control.

Compression is produced by a slotted rotor with sliding interchangeable blades. The bypass relief valve in the top of the oil chamber returns unused gas to the pump suction. The valve may be weighted to open at any desired pressure, which will be maintained at all times, regardless of the amount of gas or air used, up to the capacity of the compressor.

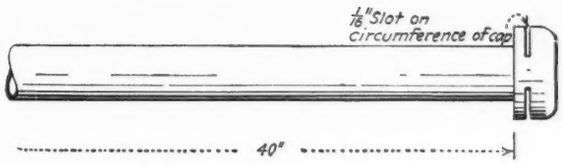


**Fig. 2—Slotted gas burner produces flame perpendicular to coal and air flow**

Using gas for lighting a pulverized-coal boiler means less labor and a more positive ignition. It is very flexible, neat and compact. The supply is constant and produces instant heat, which is a necessity in such work.

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# All-Welded Boiler Drum For Louisiana Plant

There has been much talk about all-welded boiler drums. Few have seen them for land use, at least, because the A.S.M.E. boiler code is in force in many states and because, in most of the others, boiler inspectors have not permitted fusion-welded drums. The drum here shown goes to a non-code state, but was made and tested in strict accord with the proposed A.S.M.E. code for fusion-welded drums published in *Mechanical Engineering*, December, 1930. It was manufactured by the Babcock & Wilcox Company at its Barberton, Ohio, plant for the Brown Paper Mill Company, Monroe, La., and will replace the riveted mud drum of a water-tube boiler. The previous drum was condemned because of a cracked seam caused by caustic embrittlement.

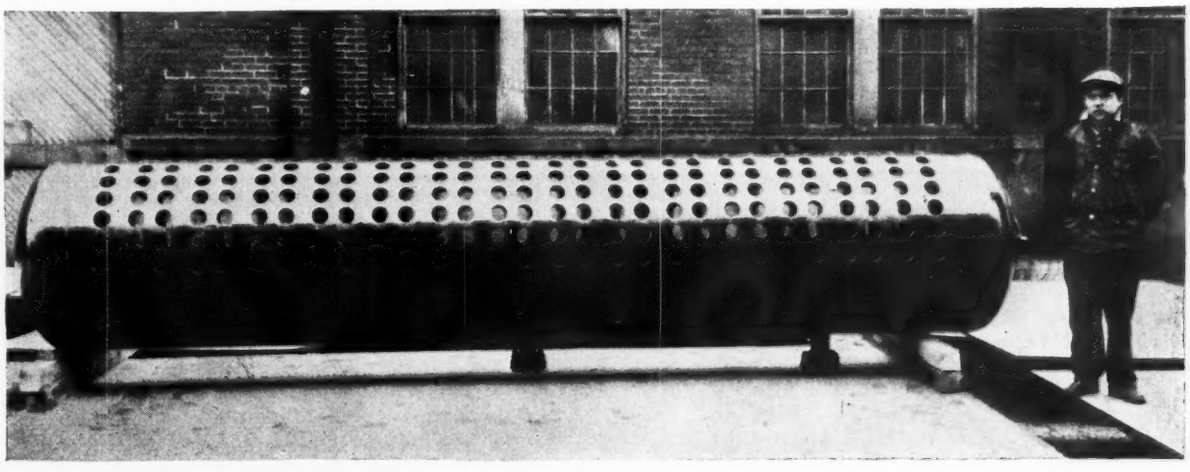
The shell was rolled up of a single plate, leaving one longitudinal butt seam to be welded by the shielded metallic arc process. The inside diameter is 36 in. and the straight shell length 16 ft., with an over-all length of 17 ft. 6 in. The shell thickness is $\frac{13}{16}$ of an inch, and the heads, flanged and dished, of semi-elliptical design, are of the same thickness.

In one end is an elliptical manhole, flanged in, size 12x16 in. The head flanges are the same diameter as the shell and butt-fusion-welded to it.

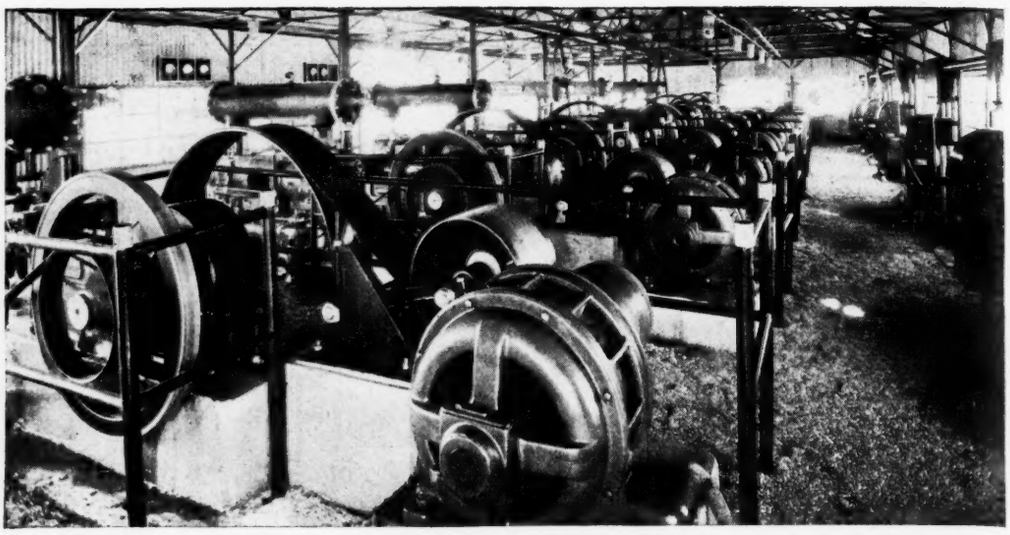
The actual strength of a drum of this sort is determined not by the weld, ordinarily, but by the tube ligaments, the tube holes being drilled on the side away from the joint. In the case of this drum the efficiency of the tube ligament is 45 per cent, which determines the safe working pressure of 207 lb. per square inch. After completion of the drum it was given a hydrostatic test at 311 lb. per square inch with hammering and a final hydrostatic test of 621 lb. Based on the working pressure, the factor of safety is 5.43.

As required by the proposed A.S.M.E. code for fusion-welded drums, the completed drum was first stress-relieved by heat, seams were X-rayed throughout and specimens from the test plates were tested physically in various ways. These included tensile tests of a specimen taken entirely from a weld metal. It showed a tensile strength of 59,900 lb. per square inch, an elongation in 2 in. of 30.5 per cent and a reduction in area of 67.3 per cent. Other tests included the bend test, Charpy impact test, specific gravity of weld metal and photographic X-ray examination of the welds.

Until a fusion-welding code is approved by the A.S.M.E. Code Committee it is the intention of the Babcock & Wilcox Company to offer such drums only in states not covered by the code.



**All-welded drum for Brown Paper Mill Company**



Seven 75-hp. squirrel-cage motors driving compressors connected to air-gas lift oil wells

# Motor Drives for Air-Lift Compressor

By E. C. DIFFENBACH
*Industrial Engineering Dept.*
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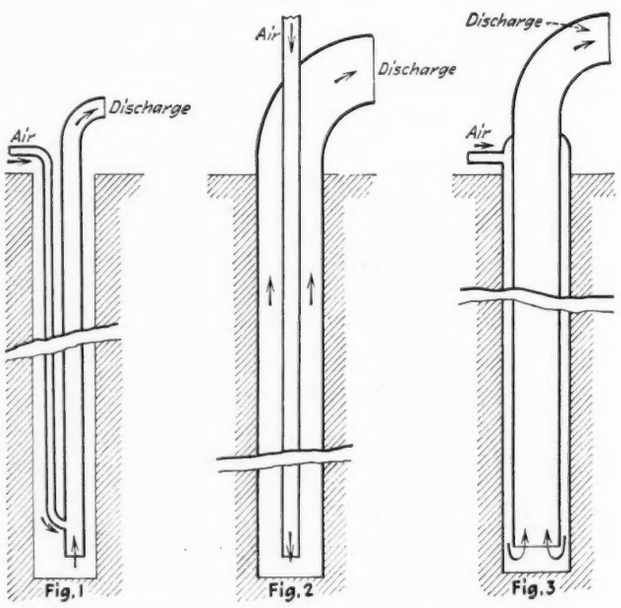
**HOW air and gas lifts for pumping water or oil operate, and the selection of motors and control equipment for driving compressors used in this service**

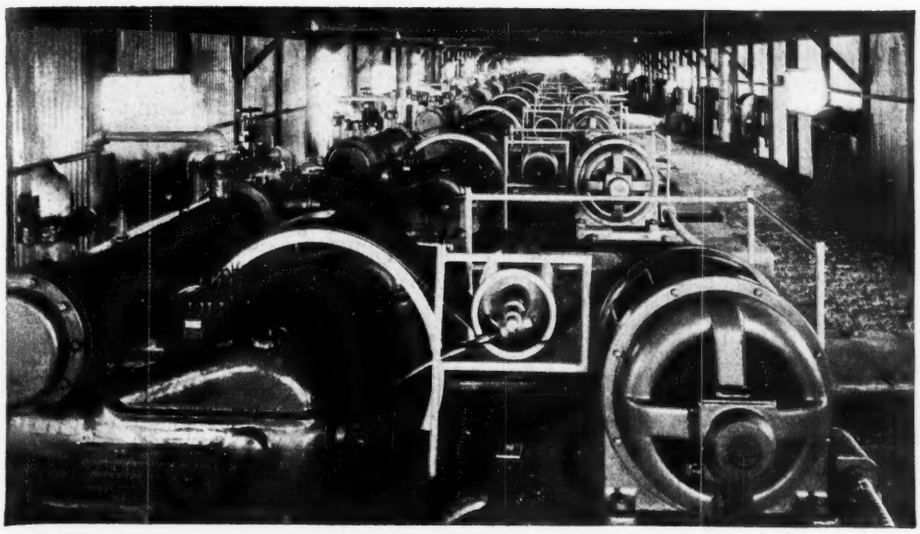
AIR LIFTS are used in municipal water-works; in the oil fields as gas lifts; in sulphur mining, deep-well pumping of dissolved or liquefied sulphur; irrigation plants; dye works; cold storage and packing plants. Power for operating air or gas lifts is supplied in the form of compressed air or gas by compressors.

An elementary air lift consists of a pipe one end of which is submerged in the liquid, compressed air being introduced at the bottom, as in Figs. 1, 2 or 3. The air mixes with and aërates the liquid and lowers its specific gravity so that it rises above the surface of the surrounding liquid. If the pipe is submerged to the correct depth, is of the proper diameter and the air pressure is great enough, the liquid will flow from the top of the pipe. The amount of the total pipe length submerged in the liquid varies from 66 to 40 per cent for water, the submergence decreasing with the increase of lift. Working submergence is determined by raising or lowering the pipe in the well until best results are obtained. Pipe sizes are limited, owing to standard casing diameters. Empirical values are available to assist in the selection of proper pipe cross-section to limit the velocity of the issuing liquid.

An air lift is started by using sufficient air pressure to support a column equal in height to the total lift. Air volume is determined from handbook values or compressor manufacturers' data. The pressure required




**Figs. 1 to 3—Elementary diagrams showing different arrangements of air lifts used in pumping liquids**



**Twenty-four 75-hp. squirrel-cage motors driving compressors connected to air-gas lift oil wells. From one to four compressors are used per well**

to operate the lift may be reduced after the column is in motion, due to less inertia and to other factors.

Air-lift efficiency, water horsepower divided by air horsepower, is low when compared to other forms of mechanical lifts, such as reciprocating, centrifugal, rotary or other kinds of pumps. However, considering the absence of underground moving parts of the air lift and the over-all efficiencies of the various other mechanical lifts, the air lift compares favorably with the former.

Electric motors for air-lift compressor drives have the advantage of low installation cost, ease of maintenance, smooth, quiet operation, and portability where that feature is desired. Where the time element is an important factor the motor and compressor can be mounted on sills, enabling the installation to be made quickly and as readily changed. Building sizes can be kept to a minimum by close connection when the set is installed indoors.

Reciprocating compressors are ordinarily driven by squirrel-cage induction motors, but for the larger sizes, 50 hp. or over, the wound-rotor and synchronous types are more widely used.

Synchronous motors for direct connection to compressor shafts are admirably suited for large lower-speed compressors. Portability is secondary in installations of this kind, since they are of a more or less permanent nature. Electric drive for compressor permits the use of the various types of control, manual, automatic or remote, in a wide range of uses.

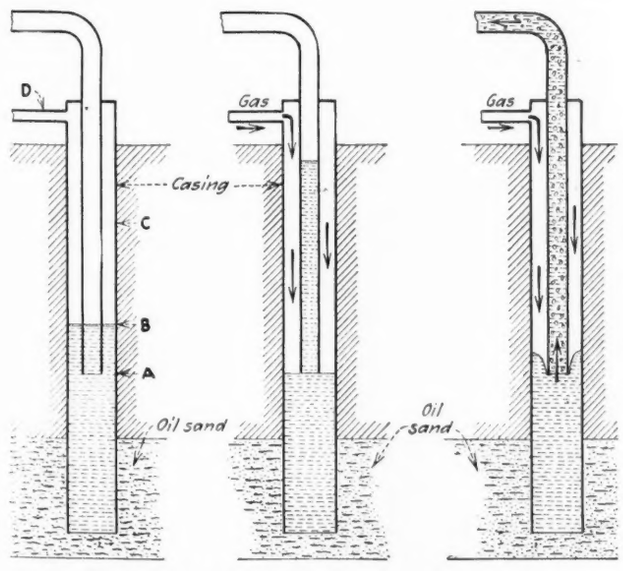



**Fig. 4—Three stages in the operation of a gas lift in an oil well, Bureau of Mines Bulletin 323 "Gas-Lift Method of Flowing Oil Wells"**

## Oil-Field Applications

A modification of the air-lift known as the gas lift is used in the oil fields to obtain production between the periods of natural flow and plunger-pump operation. Compressed gas is introduced at *D*, Fig. 4, where it enters the pump casing *C*, causing the oil to recede from the level of static head at *B* to the bottom of the eductor tube at the working submergence. The displaced liquid rises up the eductor tube and, as the flow of compressed gas continues, it enters the column in the eductor tube, aërating it and lowering the specific gravity of the mixture. The pressure in casing *C* momentarily decreases and then increases as the bottom of the eductor tube is covered and uncovered. The cycle rapidly repeats, producing a nearly constant discharge from the top of the eductor tube.

Work done in the air lift is the product of the weight of fluid discharged in pounds and the distance lifted in feet. The velocity of the issuing liquid and completeness of the expansion at the top are important points for consideration. The efficiency of the average gas lift is about 15 to 18 per cent, and when the over-all efficiency is considered the gas-lift efficiency compares favorably with other mechanical methods of pumping oil from deepwells.

Compressor drive is one of the principal problems connected with the gas-lift. The electric motor simplifies it consideraby and offers a wide selection of speeds, torques and control possibilities. Portable outfits mounted on skids or sills give the operator a means of testing the well before it is tied in with the gas line from the central compressor plant.

High-starting-torque squirrel-cage motors with across-the-line starting have been found to give good service because of their simplicity and ability to function under severe service. Where provision for bypassing is made so that the starting torque is not too great, the standard squirrel-cage motor is suitable. However, if the compressor is not unloaded before starting, the squirrel-cage motor with auxiliary winding or the wound-rotor induction motor are necessary.

Synchronous motors, when applied to slow-speed

reciprocating compressors, are available for attaching directly to the compressor shaft by split-rotor or split-hub construction. The normal 40 per cent starting torque and 40 per cent pull-in torque are satisfactory unless the compressor is to operate under very low pressures. In such cases a relatively small motor would operate the compressor after starting. Applications of this require careful checking to supply a motor of high starting torque as compared with running torque.

Another consideration when applying a synchronous motor to a reciprocating compressor is the flywheel effect. To supply sufficient torque to the compressor

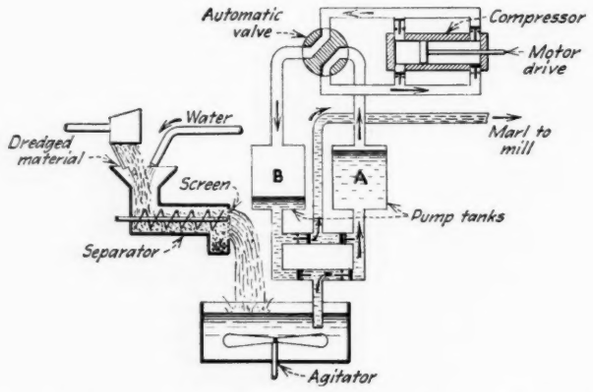



**Fig. 5—Diagram of pneumatic displacement system of pumping**

shaft, on account of variation in torque during each revolution, sufficient flywheel effect must be supplied by the rotor or by an auxiliary flywheel. The torque variation should be kept down so that pulsations in the current drawn by the motor are not more than 66 per cent of total full-load motor current. Manufacturers of electrical machinery can supply valuable aid in selecting motor sizes for compressor applications.

### Group Pumping

The jack well system of pumping is in common use for group pumping where individual production does not warrant an installation for each well. Belt or gear connection through a countershaft to a bandwheel offers a flexible method for securing the low speeds required at the jack pump.

Such equipment should be as simple as possible; the squirrel-cage induction motor is usually satisfactory; the wound-rotor motor can be used if desired. When starting up a group of cold wells, a good starting torque is necessary. A high-torque squirrel-cage motor designed to start without an excessive current rush when thrown across the line has been found to be satisfactory.

### Pneumatic-Displacement Pumping

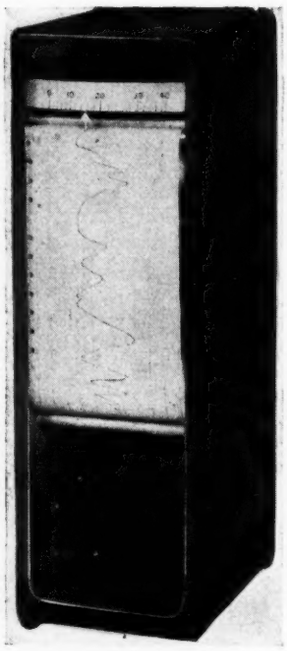
The marl pump, a special application of the pneumatic displacement pump, is used to transfer marl from the natural deposit to the point of use, where it is converted into byproducts of lime, as portland cement, etc. The essentials of the marl pump and related equipment are shown diagrammatically in Fig. 5. The material is fed into a hopper where it is mixed with water and forced through a mechanical separator, the roots, stones and other waste materials are extracted and cast aside, while the finely divided particles pass with the water through the screen into the storage tank. An agitator keeps the mixture in constant mechanical suspension. Tanks *A* and *B* are alternately filled and discharged by means of compressed air; an automatic valve is so arranged that the operation is reversed as soon as one tank is filled and the other is emptied into the mill-pipe line. Marl has been successfully transferred by this method through a 12-in. pipe-line for a distance of two miles; the air pressure employed was 75 to 95 pounds per square inch. One of the chief problems of pneumatic displacement pumping, as with the air lift, is one of compressor drive, as discussed for the air and the gas lift.

# Electron Tubes Broaden Field Of Recording Instruments

Recording instruments such as voltmeters, ammeters and wattmeters, have always been less sensitive than corresponding indicating instruments, the result of the mechanical burden placed upon the instrument by the recording pen. The inertia of such a weight has made it impossible for a recording instrument to respond as quickly or to as small quantities as could an indicating instrument.

Now, by the application of a different principle, the General Electric Company has produced recording instruments of increased sensitivity and accuracy. A beam of light has no weight; so by incorporating photo-electric and pliotron tubes in recording instruments it has been made possible to record quantities where only a limited amount of energy is available.

In the photo-electric recorder the inking pen is driven by a small high-torque element supplied from an auxiliary source of energy. Directly beneath the recording element is an indicating instrument element that is operated by the quantity to be recorded. A photo-electric circuit and an optical system cause the recording element to follow the indicating element and make a continuous record of the deflection. In this manner any quantity indicated can also be recorded. The only mechanical burden placed upon the indicating element is a tiny galvanometer mirror. For ordinary applications, miniature indicating instrument elements are satisfactory, and result in a minimum energy requirement from the circuit which is being measured. The instruments can be of the most sensitive types.



**Exterior view of photo-electric recording meter**

# Waste Heat Recovery in Oil Engine Plants

By MAJOR W. GREGSON*

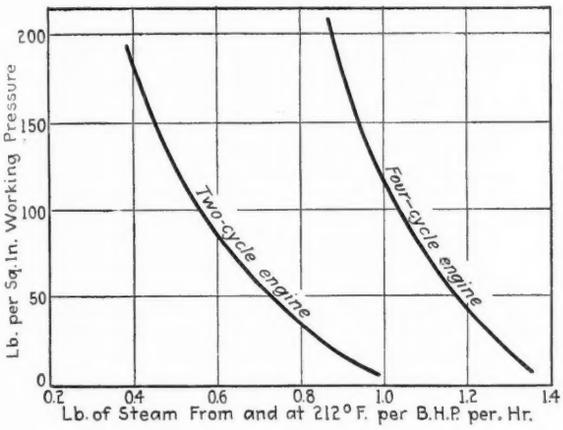



**Fig. 1—Steam recoverable from exhaust gases**

IN THE oil engine the heat of combustion not converted into work is lost through two avenues: the cooling water and the exhaust gases. Any economic method, therefore, of utilizing these otherwise wasted heat units can be credited to the engine as an addition to the useful work carried out by its normal functions.

Of the 60 per cent of the heat energy in the fuel lost through the two sources mentioned, the slightly larger fraction is lost in the cooling water. But mechanical operation of the ordinary diesel engine demands that the cooling water shall leave at a reasonably low temperature; hence, owing to the low-temperature level of this heat, it is very difficult to recover.

Occasionally, if the cooling water is reasonably pure and fresh, a fraction can be used as warm feed for the waste-heat boiler utilizing the other source of loss, the exhaust gases, or may be employed in process work.

Some 29 per cent of the total heat in the original fuel appears as heat in the exhaust gases; in the case of the four-stroke-cycle engine an exhaust gas temperature of 700 to 750 deg. F. is normal at full load; but on two-stroke-cycle designs this figure becomes 500 to 550 deg. F., owing to the effect of the scavenging air, which dilutes the exhaust gases. The amount of dilution and resultant effect on the waste-gas temperature varies with different designs of engine.

The degree of extraction by steam raising or by water heating is obviously determined by the temperature of the steam or water concerned. The higher the temperature of the product the lower the available range of heat extraction. Assuming the exhaust gases to be cooled by a waste-heat boiler or heater to, say, 400 deg. F., a figure compatible with a boiler steam temperature of 330 deg. F., which would represent a working pressure of approximately 90 lb. per square inch, then the proportions of total heat available as steam would be: For the four-cycle engine, $\frac{725 - 330}{725} = 0.54$ and for the two-cycle engine, $\frac{525 - 330}{525} = 0.37$.

Assuming in each case that the engine takes 0.4 lb. of 18,900 B.t.u. fuel per brake-horsepower hour, and allowing 10 per cent for radiation losses, the heat recovery per brake-horsepower hour will be as follows: For the four-stroke-cycle engine, $0.54 \times 0.29 \times 0.4 \times 18{,}900 = 1{,}180$ B.t.u., and for the two-stroke-cycle engine, $0.37 \times 0.29 \times 0.4 \times 18{,}900 = 810$ B.t.u.

Converted into pounds from and at 212 deg. F., these figures become 1.22 and 0.84, respectively, which are fairly representative for both types of engines operating on boilers working at 90 lb. pressure.

It may be thought that the author, in taking 750 deg. F. and 550 deg. F. as the respective waste-gas temperatures, has erred on the high side, but his practice has shown him that these figures are reasonable ones, assuming a compact, well-lagged exhaust-pipe line.

Certain engines of each class, however, consistently run a lower exhaust temperature; but in these cases the reason is greater dilution of the products, that is, a higher excess air content increasing the volume and lowering the temperature.

A point of great importance is that manifold temperatures are often recorded incorrectly by not allowing the thermometer or couple to be properly inserted in the gas flow, and secondly, by the general effect (when using

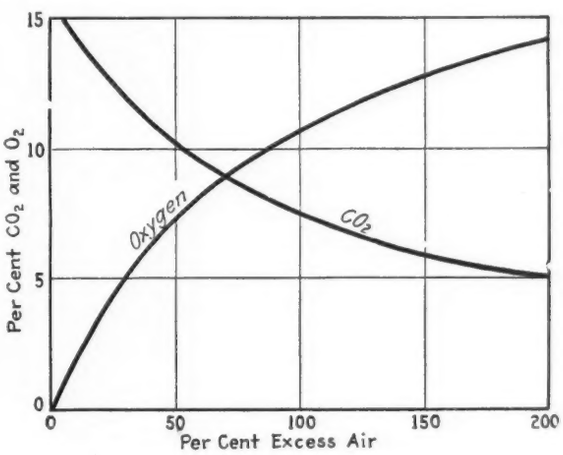



**Fig. 2—Oil engine exhaust gas analysis**

*Abstract of paper presented before the Diesel Engine Users' Association, Dec. 12, 1930.

thermocouples) of the heat transfer by a little radiation from the couple itself to surrounding objects of lower temperature, by giving a low reading.

A second point to be considered is that of waste-heat recovery output at lower engine load. The temperature $T$, is immediately lowered; if this were the only variable factor the new figure for steam per brake horsepower would be proportional to the new temperature drop. But two additional factors operate in the reverse direction to the temperature factor: The excess air content is increased at lower loads, and the fuel per brake-horsepower hour also increases. Hence the standard rating may be corrected for low loads as follows:

Let $S$ = Normal steam, full load (lb. from and at 212 deg. F.).

$S_f$ = Steam at lower load under consideration.

$T_1$ and $T_f$ = Respective waste gas temperatures.

$V_1$ and $V_f$ = Respective volumes, based on Table II and assessed from the $CO_2$ values.

$W_1$ and $W_f$ = Respective fuel oil, lb. per brake-horsepower hour.

Then

$$S_f = S \times \frac{T_f - T_2}{T_1 - T_2} \times \frac{V_f}{V_1} \times \frac{W_f}{W_1}$$

It might be argued that by adding a feed heater in series with the boiler considerably greater efficiency could be obtained; as outlined above, 100 per cent extraction efficiency represents bringing the gases down to steam temperature only. Theoretically, the feed heater is sound economics; practically, it is not, unless it is operated at high water temperatures, that is, at temperatures corresponding to steam temperatures.

The reason is that slight traces of sulphur in the fuel oil ultimately form sulphuric acid in contact with gases below dew-point; hence maintenance troubles rule out the low-temperature heater. This does not, of course, eliminate heaters entirely: Heaters are quite effective if operated under temperature conditions corresponding to those obtaining in low-pressure boilers, provided care is taken no avoid working at low water temperatures. The boiler is, of course, self-adjusting over this matter, because, providing it is making steam, the gases must leave at a higher temperature than steam temperature.

The principles determining the design of waste-heat boilers are quite different from those pertaining to fuel-fired practice, the main reason being that the radiant-heat factor is small at temperature as low as 700 deg. F. In other words, the boiler has to be designed as a heat-absorbing unit, utilizing convection effect only. This means that intimate contact between boiler-heating surface and the exhaust gases is the first consideration: The gas flow must be prevented from stream-lining and must be broken up so that each molecule gets into the closest possible contact with heat-absorbing surface, sweeping away any inert non-conducting film.

This can be effected either by arranging the heating surface so that its disposition breaks up the gas stream,

TABLE I—THEORETICAL AIR SUPPLY (86 PER CENT CARBON 12 PER CENT HYDROGEN

| | Weight per Lb. of Oil | Oxygen Required for Theoretical Combustion | | Combustion Products | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | $CO_2$ | | Water Vapor | | Nitrogen | |
| | | Cu.Ft. | Lb. | Cu.Ft. | Lb. | Cu.Ft. | Lb. | Cu.Ft. | Lb. |
| Carbon..... | 0.86 | 25.8 | 2.3 | 25.8 | 3.16 | .... | .... | 98.5 | 7.7 |
| Hydrogen..... | 0.12 | 10.8 | 0.96 | .... | .... | 21.6 | 1.08 | 41.0 | 3.2 |
| | .... | 36.6 | 3.26 | .... | .... | .... | .... | 139.5 | 10.9 |

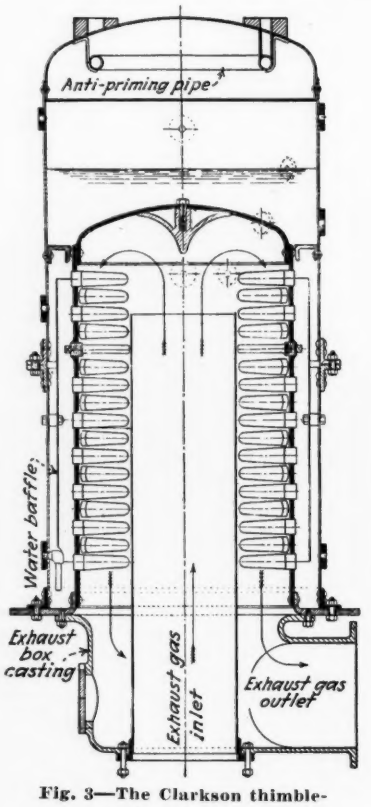



**Fig. 3—The Clarkson thimble-type boiler**

or, alternatively, by working at velocities above the critical speeds of stream-line gas flow—setting up turbulence and so greatly increasing the coefficient of heat transfer.

Either system means setting up resistance to flow of the gas; but, fortunately, the oil engine can stand reasonable back pressures. Hence no induced draft fan is required to overcome this resistance to gas flow which can be superimposed on the engine circuit.

This inherent necessity for active contact heating is the reason why a good fuel-fired boiler is not a good waste-heat boiler, and vice versa. Where it is desired to combine the two functions of waste-heat recovery and oil firing, special arrangements are necessary in formulating a satisfactory dual design.

The number of designs that have been tried for diesel recovery is almost legion, and the bulk of them have not persisted beyond the first few examples. Ordinary designs of water-tube boiler suffer from the difficulty of keeping the casing gas tight, and also require a very deep nest if reasonable efficiency is desired. The ordinary return-tube oil-fired boiler adapted for waste-heat recovery grew up as a fuel-fired boiler, and is not efficient on a diesel exhaust without radical redesigning. Furthermore, some of the examples tried out and found wanting put far too much back pressure on the engines.

The best-known examples of high-efficiency waste-heat boilers that have really proved effective over the complete range of oil engines, and which, incidentally, have stood the combined test of long-period low maintenance plus high-recovery efficiency, are the Spencer-Bonecourt and the Clarkson.

The Spencer-Bonecourt boiler is inherently a fire-tube design, operating at high gas-flow velocities to obtain turbulence. Vertical and horizontal units are standardized; for alternative fuel-oil firing a modified return-tube unit, with, however the heating surface designed for most effective low-grade heat recovery, is built as a horizontal design. For the vertical combination boiler a screen of water tubes above the oil-firing furnace section is added to the standard straight waste heat boiler.

The Clarkson boiler, Fig. 3, is a thimble-tube boiler; the disposition of the thimbles is such as to break up the gas streams and so maintain high transmission figures. Oil firing is easily added as an auxiliary or, in a modified design, as simultaneous "make-up" firing. The Clarkson boiler is essentially a vertical unit.

The Cochran combination boiler, Fig. 4, is practically a standard oil-fired Cochran vertical boiler with the addi-

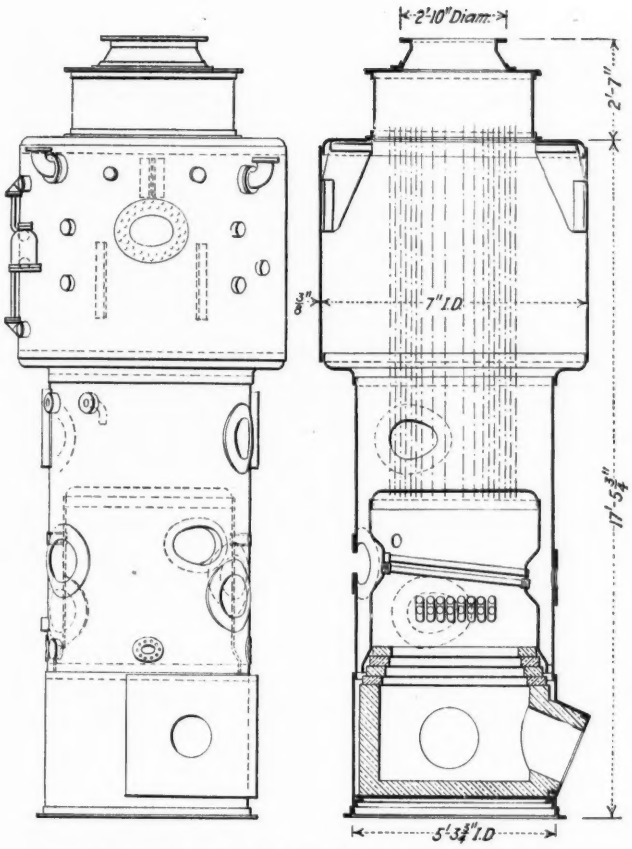



**Fig. 4—The Cochran vertical waste-heat boiler**

tion of a double pass of waste-heat tubes, that is, its waste-heat section operates on the same lines as the Spencer-Bonecourt, but with a double pass instead of a single pass of recovery tubes. There is also a Cochran design eliminating the oil-fired section, for straight waste-heat recovery jobs.

Waste-heat boilers on board ship operate under two very favorable conditions: The water is normally good

TABLE II—COMBUSTION PRODUCTS PER POUND OF OIL WITH VARYING PERCENTAGES OF EXCESS AIR

| Excess Air, Per Cent | $CO_2$ | $O_2$ | Total Volume Water as Vapor | Total Volume Water Condensed | Per Cent "As Measured" $CO_2$ | Per Cent "As Measured" $O_2$ |
|---|---|---|---|---|---|---|
| 0 | 25.8 | .... | 186.9 | 165.3 | 15.6 | .... |
| 50 | 25.8 | 18.3 | 274.9 | 253.3 | 10.2 | 7.25 |
| 100 | 25.8 | 36.6 | 362.9 | 341.3 | 7.5 | 10.7 |
| 150 | 25.8 | 54.9 | 450.9 | 429.3 | 6.0 | 12.8 |
| 200 | 25.8 | 73.2 | 538.9 | 517.3 | 5.0 | 14.2 |

and the gases are comparatively clean. Boiler cleaning, therefore, provided it is carried out at reasonably fair intervals, is not an arduous or difficult operation. In fact, the standard makes of boiler allow of very simple and effective cleaning.

▼

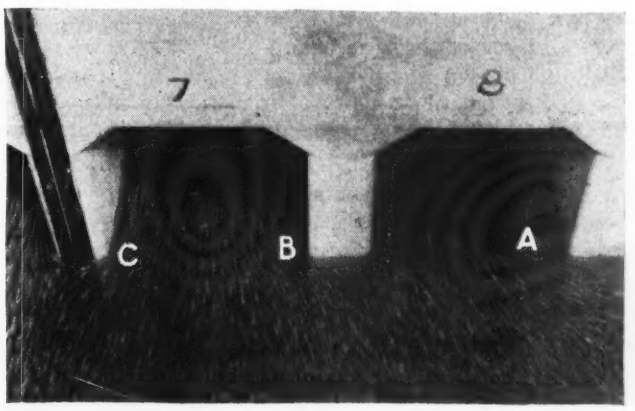
TOTAL POTENTIAL WATER POWER of the McKenzie River Basin in Oregon, without storage, is 290,000 hp. for 90 per cent of the time and 444,000 hp. for 50 per cent of the time, according to Benjamin E. Jones, hydraulic engineer, and Harold T. Stearns, geologist, of the United States Geological Survey, Department of the Interior. With storage at four proposed reservoir sites the potential power for 90 per cent of the time would be increased to 325,000 hp., but potential power for 50 per cent of the time would remain unchanged. Two have been built by the city of Eugene, with an installed capacity of 14,300 hp. These and other pertinent facts are set forth in Geological Survey Water-Supply Paper 637-C, obtainable from the Superintendent of Documents, Washington, D. C., for 15 cents.

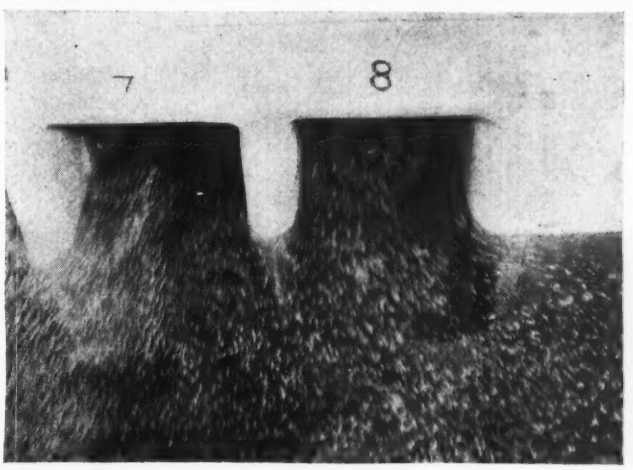
# Model Tests Made on Penstock Intake

THE TWO PHOTOS show the flow through a penstock intake model which was running about one-half full when the pictures were taken by Prof. C. M. Allen at the Alden Hydraulic Laboratory, Worcester Polytechnic Institute, Worcester, Mass. This experiment was made to show the effect of squared and rounded corners on the intake piers.

In Fig. 1 the corners of the piers are square and the eddies just downstream from the corners are clearly apparent at *A, B* and *C*. At the right the forebay chamber wall sets back about the distance between piers away from No. 8 intake, to form a square corner in the forebay chamber. The flow away from the right-hand wall of the forebay chamber is such as to deflect the water away from the right-hand pier in No. 8 intake against the center pier, and accounts for the larger eddy at *A* than at *B*.

Note the absence of eddies inside the intake in Fig. 2. In this test the corners of the piers are rounded to conform to streamline flow. But even in this test there is evidently a tendency for the water to flow away from the right-hand side of the forebay wall toward the center of No. 8 intake, as indicated by the lines on the waters surface.




**FIGS. 1 AND 2—WATER FLOW INTO A MODEL OF A PENSTOCK INTAKE**

Fig. 1 (Top)—Square corners on the piers in the intake cause eddies at *A, B* and *C*. Fig. 2 (Bottom)—Corners of the piers have been rounded, note the absence of eddies.

# Effect of Turbulence on Mixture of STEAM and AIR in RADIATORS

**EXPERIMENTS** in laboratory and field have shown that although temperature and pressure have an effect on the heating of a radiator the controlling factor is the degree of turbulence produced by the entering steam

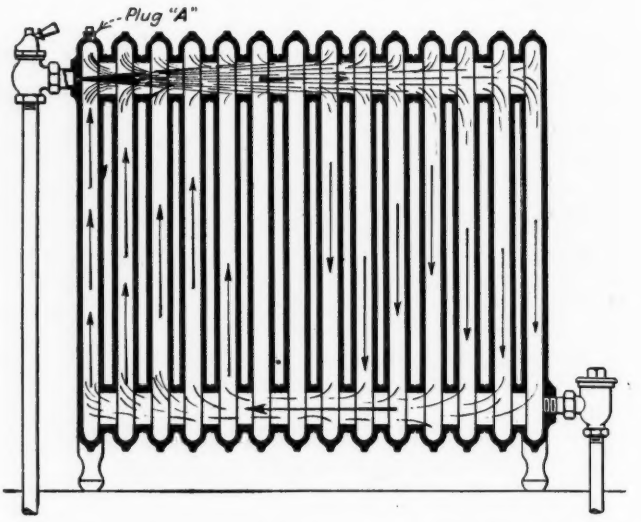



**Fig. 1—Illustrating turbulence produced within cast iron radiator by high velocity steam entering through an orifice**

By KARL W. ROHLIN

*Engineering Dept.*
*Warren Webster & Co.*

WHY do not steam and air mix in radiators? The answers to that question in the March 24 number of *Power* were apparently derived from reasoning rather than from actual tests. The ordinary radiators installed in most buildings heat near the supply end just after steam is turned on, gradually heating throughout as more steam enters. Steam entering the top of the radiator at one end drives the air originally in the radiator before it and discharges it through the open trap at the lower, opposite, end of the radiator. Like cold air blowing in an open window, it soon displaces all of the original contents.

On coming in contact with the colder iron walls of the radiator the steam condenses and more steam flows from the inlet connection of the radiator to take its place. A moderate draft is set up which gently moves air and other gases that were in the radiator on starting, or that enter with the steam, toward the radiator outlet. Heavier gases and air, therefore, concentrate near the trap connection, and, if the steam has sufficient pressure to fill the radiator, are discharged through the trap.

In the above case practically no mixture of air and steam takes place, despite the natural tendency to do so. Instead, concentration takes place, due to the low velocities in the radiator and to the higher density of air, so that the temperatures of the bottom and at the trap outlet of the radiator are 5 deg. or more below the temperature of steam corresponding to the existing pressure.

Feeling a partly heated radiator with the hand will fully substantiate the above. It is always hot, practically 212 deg., near the supply valve, and considerably cooler, or cold, near the trap outlet connection.

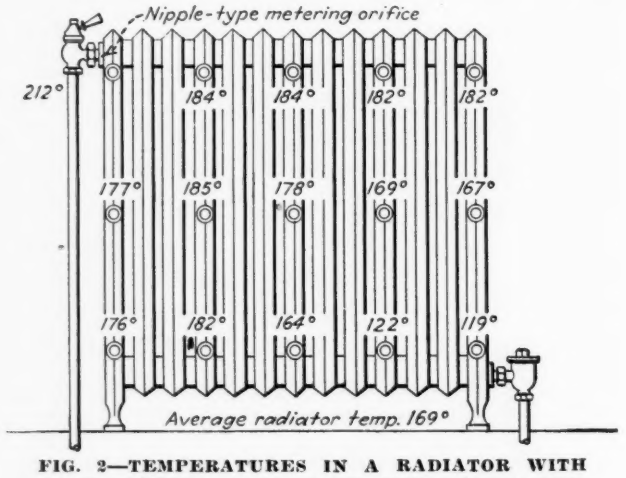



**FIG. 2—TEMPERATURES IN A RADIATOR WITH INLET ORIFICE AND OPERATING AT ATMOSPHERIC PRESSURE**

50 sq.ft. rad.; room temp., 84 deg. F.; condensing rate, 6.4 lb. per hour. (One-half of maximum.)

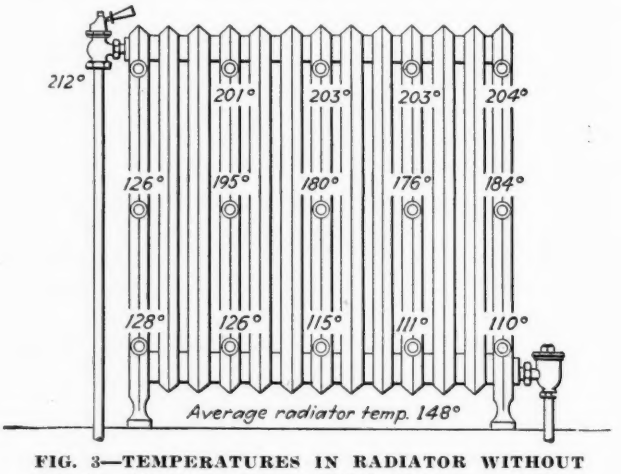



**FIG. 3—TEMPERATURES IN RADIATOR WITHOUT INLET ORIFICE AND OPERATING AT ATMOSPHERIC PRESSURE**

50 sq.ft. rad.; room temp., 73 deg. F.; condensing rate, 6.3 lb. per hour. (One-half of maximum.)

But entirely different things happen if the steam is injected into the radiator at higher velocities. Positive mechanical mixture of the air and steam then takes place and the temperatures of different parts of the radiator become more uniform than would be the case under ordinary conditions. An orifice or nozzle applied at the inlet of any radiator designed so that free circulation of air and steam can take place will produce this effect.

The distribution of the steam-air mixture results in more even distribution of heat throughout the whole radiator, and the temperature of the hottest part of the radiator is considerably below the temperature of steam at the entrance. This is equally true at all pressures. It is not affected by or dependent upon the pressure in the radiator being above or below the atmosphere.

Fig. 1 illustrates the behavior of steam and air in a so-called "hot-water" radiator having an orifice at its steam inlet. Actual tests show that, even with a pressure difference across the orifice of only $\frac{1}{4}$ lb., the steam jet gathers air from the first few radiator sections and carries it rapidly across the top of the radiator, down the opposite end sections, returning it through the bottom nipples and up the first few sections of the radiator to the inlet again. With pressure differences of 1 lb. or so this effect is so pronounced that a vacuum of $\frac{1}{4}$ in. of mercury will be observed at plug *A* in a radiator open to the atmosphere at its outlet.

Temperature measurements were made on a 50-sq.ft. radiator provided with an inlet orifice as shown in Fig. 1. When condensing steam at half its maximum rate the temperature varied only between 164 deg. and 184 deg., except for the corner near the trap, as shown in Fig. 2. Similar temperature readings were made when the radiator was condensing the same amount of steam, but without an inlet orifice. The temperatures indicated in Fig. 3 show that the mixture of steam and air has not been promoted, as one portion of the radiator is hot while the other is practically cold. This is the way unorificed "hot-water" radiators generally perform.

Practically the same temperatures were obtained when the pressures within a radiator equipped with an orifice were lower than the atmosphere, as shown in Fig. 4. Radiator temperatures were changed only by a change in the delivery of steam to the radiator. When the unorificed partly heated radiator shown in Fig. 5 was operated at a vacuum the temperature of the heated portion was reduced and the amount of surface heated increased somewhat. In this particular test the steam delivery to the radiator and the condensation rate were 10 per cent higher than in the other tests.

When the steam inlet and orifice are at the bottom of a hot-water radiator, the injector effect is produced in the bottom tubes instead of the top. Distribution of heat throughout the whole radiator is effectively produced just as for the top inlet connection. In the steam radiator with nipple connection at the bottom only, the absence of a second nipple connection at the top of the radiator section effectively prevents turbulence and steam-air mixing. The velocity of the steam after entering the radiator rapidly falls to zero, and only the sections nearest the supply connection are heated. As more steam is admitted to the radiator, sections farther from the supply connection are heated. This radiator fitted with an orifice heated exactly the same at it would without an orifice, due to the effective elimination of turbulence.

## Tandem-Connected Units

In loft buildings occasionally two radiators are connected in series by two 2-in. nipples. This tandem radiator connection is used because of the economy in supply and return connections.

It was apparent from tests on this type of connection that the first radiator receives practically all of the steam, and the second receives little until the first one is nearly fully heated. The jet from the orificed inlet distributed the steam in the first radiator, but little of the jet reached the 2-in. pipe connection and it remained cold until the first radiator was practically half heated.

In an effort to improve the distribution when the tandem-connected radiator was used, the orifice was placed 12 in. away from the 2-in. connection. Under these conditions the jet was so effective that the second radiator heated considerably before the first one. The temperatures recorded indicated clearly that the steam circulated in the top nipple between the two radiators, down the first sections of the second radiator, back through the bottom nipple between the radiators and up the last section to the first radiator.

Another test was made on a 50-sq.ft. radiator that had been air-bound for $1\frac{1}{2}$ hr. On starting up this radiator a pet-cock air vent was cracked until the condensation rate of the radiator was approximately half its maximum. The petcock was then closed and conditions in and around the radiator kept constant for $1\frac{1}{2}$ hr. The tem-

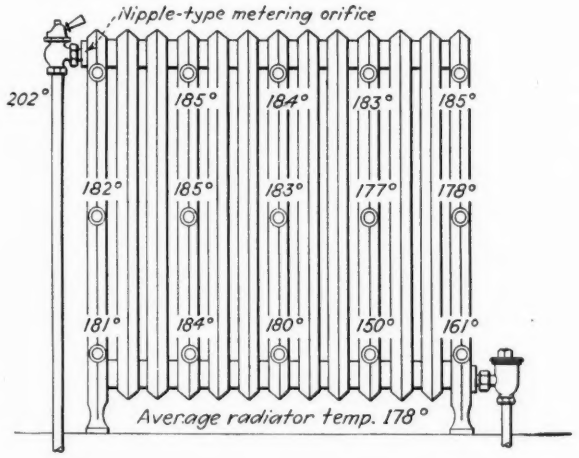



**FIG. 4—TEMPERATURES IN RADIATOR WITH INLET ORIFICE AND OPERATING UNDER VACUUM**

50 sq.ft. rad.; room temp., 80 deg. F.; condensing rate, 6.26 lb. per hour. (One half of maximum.)

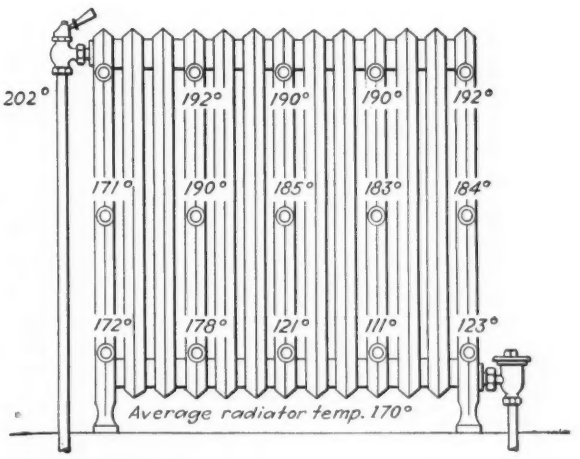



**FIG. 5—TEMPERATURES IN RADIATOR WITHOUT INLET ORIFICE AND OPERATING UNDER VACUUM**

50 sq.ft. rad.; room temp., 78 deg. F.; condensing rate, 6.78 lb. per hour. (55 per cent of maximum.)

perature readings obtained were nearly identical with those shown in Fig. 2.

All of the tests were run in a laboratory where other work was in progress. The movement of air over the test radiator could not be controlled, and accounts for the difference in the average temperatures in two tests with the same condensing rates. A sudden increase in air movement, due to the opening of windows or doors, would drop the radiator temperature 10 deg. or more. Nevertheless, each test does indicate clearly the steam distribution within a radiator under a given set of operating conditions.

From the above it will be noted that while it is true that density, temperature and pressure all affect the homogeneity of vapor-gas mixtures, they have no appreciable effect on the conditions within ordinary heating radiators. Normal currents either concentrate the air in one section of the radiator, or, when properly directed and augmented by the use of an orifice or nozzle, can be made to distribute the steam-air mixture with fair uniformity throughout the whole radiator.

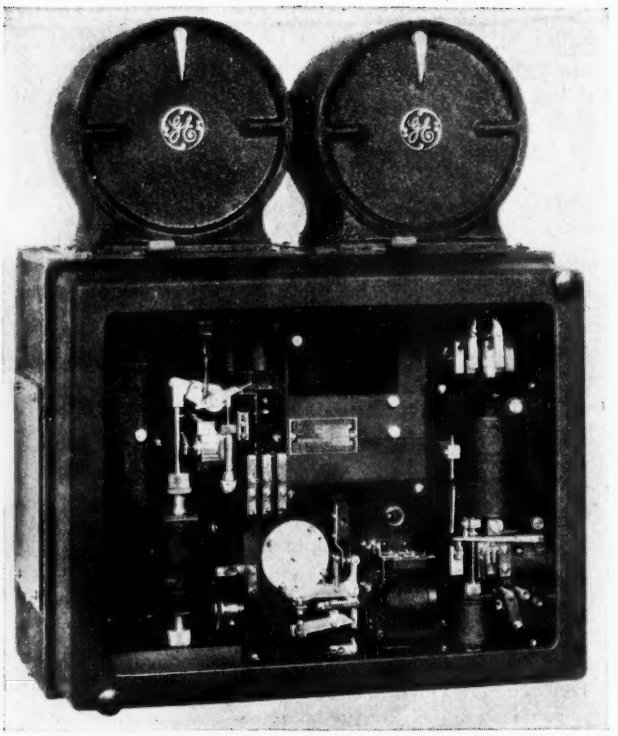
▼ ▼ ▼

# Oscillograph Records System Disturbances Automatically

IT IS NOT SO LONG AGO that the oscillograph was looked upon as a laboratory instrument. But the demand for more accurate information of power-system operation, that cannot be had with ordinary recording meters, has led to a greatly extended use of the oscillograph as a power-station device. Transient disturbances on electric power systems, such as accidental short circuits and similar phenomena, are now recorded automatically by an oscillograph. The instrument provides definite information of magnitudes of current obtained during system disturbances, thereby affording a check on short-circuit calculations, on the rupturing duty imposed on circuit breakers, and on relay settings. The device also provides a continuous check on relay operation. With the advent of high-speed switching and relaying, it provides a precise means of keeping a continuous check on the actual speed of relays and circuit breakers under operating conditions, and thereby the means for detecting and correcting any difficulties which may develop.

A development model of the new oscillograph was used during some staged system tests, when records were also made with standard oscillographs. The automatic oscillograph performed satisfactorily during all the tests. In one or two cases it obtained records which the standard oscillograph did not obtain, because of a misunderstanding in the correlation between the time of throwing on the short circuit and of starting the standard oscillographs. The automatic oscillograph was installed later on an operating system, and many records of transient disturbances were obtained.

The device contains six oscillograph galvanometers of standard construction, and makes a record on sensitized paper $4\frac{1}{4}$ in. wide. A unique feature of the instrument is in its ability to start the record in less than a half cycle. The instrument is designed for mounting either on a table in the usual way, or on a switchboard panel in case it is desired to install it as a piece of permanent station equipment. For this purpose the connection binding posts on the back are replaceable by studs which project through the panel for making connections to the back.



**Front view of automatic oscillograph**

The record is made not on standard photographic film but on a special bromide paper obtainable in 200-ft. lengths, with the exposed and unexposed rolls of paper stored in two magazines on top of the instrument. Indicators show the amount of paper in each magazine.

The oscillograph is build by the General Electric Company and operates automatically without attention until the 200 ft. of paper has been exposed. At any time, and without disturbing the unexposed paper, the exposed portion may be cut off and developed immediately after a disturbance. To correlate records with system disturbances the instrument has contacts to give an indication by bell or annunciator each time it operates, and with a counter which counts the operations so that the station operator can note the date and time of each operation along with the record number, thereby identifying each record.

The oscillograph is put into operation by neutral current. The starting relay starts the motor which drives the paper, and at the same time puts in motion a mirror arrangement by which the light beams are swept along the paper in a direction opposite to its motion during the period in which the paper is coming up to speed. By this means the record is started in less than a half cycle and, by properly correlating the motion of the mirror to the accelerating characteristics of the paper, a reasonably uniform time axis is obtained throughout the whole record.

The film speed being approximately 12 in. per second, 200 sec. of exposure can be obtained without changing the film. The oscillograph will run for predetermined times, adjustable from 2 sec. minimum to 20 sec. maximum. If at the end of the predetermined period of operation the disturbance persists, the record will be continued for another similar period. A three-phase wattmeter element, available in case a record of power is desired, can be installed in place of two of the standard elements.

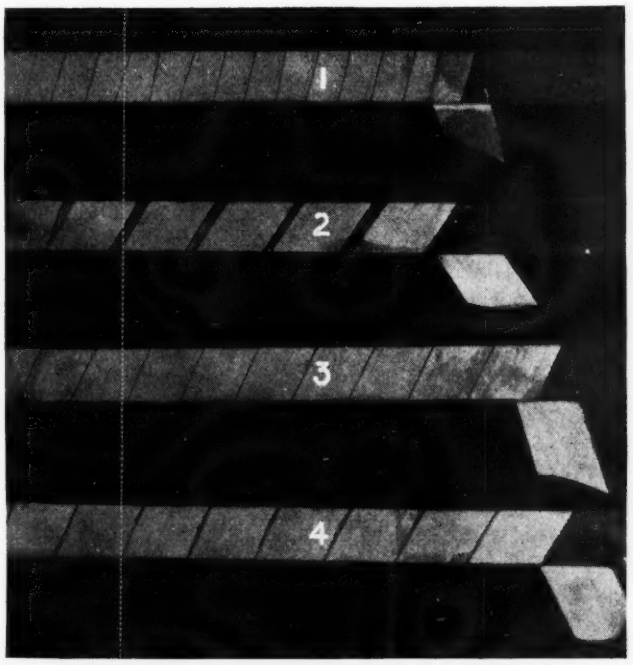
# . . . RIGHT OUT OF THE PLANT . . .

## Methods of Applying Tape to Armature and Field Coils

WHEN applying tape to armature, stator, or field coils, there are five different methods that can be used. Half-lapped, when each succeeding turn of tape is put on by guiding the left-hand side of the tape along the center-line of the preceding turn, as in Fig. 1. Half-lapping provides a wall thickness of material equivalent to twice that of the tape used. If the lapping is close, the layer can be considered as a double thickness, but if the lapping is spread apart, there will be sections in each turn having only one thickness of material. Therefore close half-lapping is essential if used to separate two adjacent conductors. Using a tape $\frac{1}{2}$-in. wide and lapping it, a tight seal can be had. The wider the tape the looser the seal will be between overlaps.

Spaced taping, Fig. 2, is done by leaving a space between each succeeding turn of tape. This adds one thickness of material per side. Space taping is used principally as a binding medium, and the spacing varies with the type of coil. When more than one layer of spaced taping is used the spaces are kept small and are covered by the next layer. This results in a double thickness per side, or is equivalent to a good half-lapping.

Edge-lapped, or slightly overlapped, taping, shown in Fig. 3, is accomplished by overlapping the edges of each succeeding turn of tape $\frac{1}{32}$ to $\frac{1}{8}$ in. One layer of edge-lapped tape is equivalent to one thickness of material, the slight overlap being to obtain a seal against dust and dirt.




**Figs. 1 to 4—Different ways in which tape is applied to coils**

Butt-taping, Fig. 4, is done by butting the edges of the tape closely so that the tape is neither overlapped nor overspaced. This provides one thickness of material and is used principally with thick tape, as asbestos, where the thickness of the coil must be kept to a minimum. Butt-taping is a slow and difficult operation. On important jobs it is necessary to pick the tape into place.

Tape can be triple-lapped, that is, two-thirds overlapped, giving a wall thickness equivalent to three thicknesses of material if carefully done.

The width of tape greatly affects the kind of lap and, also, the general finish of the coil. Likewise, the cross-section of the coil to be taped affects the width of the tape and lap.

For example, small armature coils use $\frac{1}{2}$- and $\frac{3}{4}$-in. wide tape; large coils 1-in. wide, and field coils 1-, $1\frac{1}{4}$- and $1\frac{1}{2}$-in. tape. Thus the width of tape and lapping can be varied to suit different applications and conditions.

Wilkinsburg, Pa. A. C. ROE.

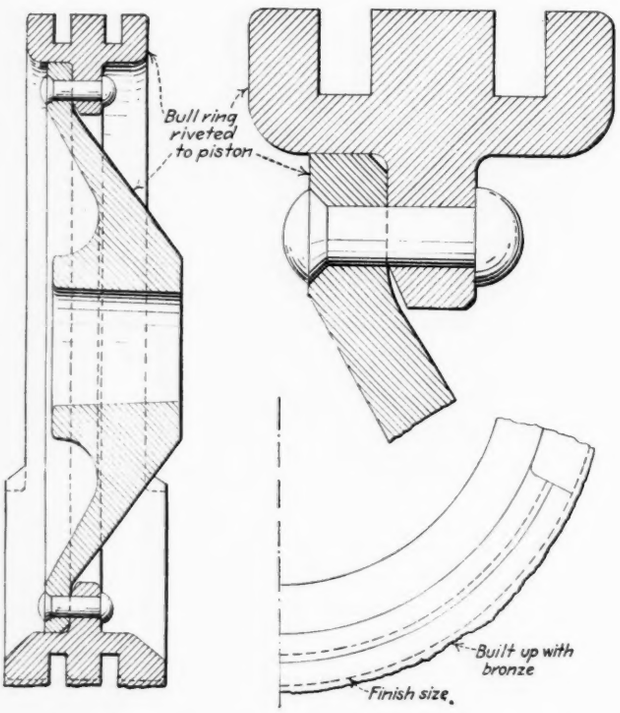
## Repairing Gas Engine Pistons by Electric Welding

IN THE MARCH 17 number, page 451, Orville Adams describes a method of reclaiming pistons by electric welding. In my opinion, this job could have been done more economically using manganese bronze applied with a torch. The method given by Mr. Adams was, briefly, to cut the piston down to a smaller diameter, shrink steel casting on the remaining portion to take the place of the metal removed in the lathe, weld the two parts together with an electric weld, and finish the piston in a lathe.

The railroads frequently have a job similar to this with worn locomotive pistons. The larger locomotives have pistons formed by riveting a cast-iron bull-ring to a spider, as shown in the illustration. When a piston becomes worn the rivets may be knocked out and a new bull ring riveted on. This saves considerable material, machining and labor over applying a new piston. However, it has been found cheaper to reclaim the bull rings by building them up with bronze, although the castings are bought on a poundage basis and are less costly than would be the case for an isolated repair job. This cost was determined by detailed studies of the cost of the gas for welding bronze, labor and other items entering

into the two methods of reclaiming the piston. The built-up pistons were found to cost about two-thirds as much as the ones reclaimed by applying new bull rings. Records were kept on hundreds of pistons, and the built-up rings were found to be at least as durable as the new ones.

It is now standard practice to apply rings $\frac{1}{16}$ in. less than cylinder diameter, and either renew them or build them up when worn $\frac{1}{4}$ in. Unless the locomotive is undergoing extensive repairs the bull rings are built up.




**Bull ring is built up with bronze then machined to size**

The wear is chiefly on the lower portion of the piston, so about $\frac{3}{8}$ in. of bronze is deposited with the torch on the bottom, tapering off to nothing on the sides. In other words, enough bronze is placed on the bull ring to allow machining down to the required size. The piston is then placed in a lathe, turned to size, the packing-ring grooves cleaned out, and the edges of the grooves chamfered. Chamfering is important, because otherwise the bronze will work over the edge of the packing ring grooves and bind the rings, causing a blow. Just enough of the corner should be beveled off to make certain the packing will be free. Between $\frac{3}{16}$ and $\frac{1}{4}$ in. is ample.

Another detail that must be watched is the kind of bronze used. Tobin bronze is too ductile and soft. Manganese bronze should be used. Following is the chemical analyses of three bronzes which have been found satisfactory.

| | Per Cent | | |
|---|---|---|---|
| Copper | 57.60 | 59.21 | 58.31 |
| Zinc | 40.14 | 38.44 | 39.57 |
| Tin | 0.79 | 0.76 | 0.58 |
| Lead | None | None | None |
| Iron | 1.45 | 1.48 | 0.88 |
| Manganese | 0.0 | 0.11 | 0.04 |
| Phosphorous | None | None | None |
| Aluminum | None | None | 0.59 |
| Undetermined | 0.01 | None | 0.03 |
| | 100.0 | 100.00 | 100.00 |

It must be understood that the manganese used in making bronze is a scavenger, which removes oxides and other impurities to the slag. The residual manganese is unimportant, 0.01 per cent being as satisfactory as 0.10 per cent.

As to the relative economies of welding a new annular ring on a piston and building the pistons up with bronze, it is only necessary to enumerate the steps required by each method.

Welding on annular rings would require the following steps: Turn down piston in lathe, chamfer edges of piston, purchase steel casting for outer ring, machine inside of casting to shrink-fit over piston, shrink casting on piston, electric-weld casting to piston, and finish piston in lathe. In comparison, building up a piston with bronze requires only three operations: Clean outside of piston for welding. Build up piston with bronze (do not build up over packing-ring grooves), and finish in lathe. The packing-ring grooves merely require cleaning out at the outer edge.

It is recognized that bronze is a better bearing metal than steel, and a piston is, in so far as its movement is concerned, a bearing sliding on the cylinder walls, so a piston may not only be built up with bronze more cheaply, but it will perform the work with less friction, less wear on the cylinder walls, and at least an equal life of the piston proper.

S. H. ACKER,
*Engineer of Tests*
St. L. & S. F. Ry.

Springfield, Mo.

## The Economic Age Limit

I WAS MUCH INTERESTED in the editorial in *Power* and in the answers to the age-limit question appearing in the May 5 number.

As for the economic age limit, I do not recognize it as such. Some of our present-day leaders made their start after they had reached the age of 40, and many great men have attained success at a much greater age. Unless an engineer out of a position is financially able to withstand a substantial decrease in salary I should not advise a change from the work in which he feels perfectly at home and in which he can expect a reasonable salary.

Personality might enable him to take up sales work in engineering lines. If he is familiar with both the steam and the electrical end of engineering it seems to me that the age-limit engineer should be able to secure and retain a position as plant engineer.

The problem is being faced by many of us today. Jobs are not being eliminated, but, in this economic depression, cheaper men are being substituted. If the engineer is financially able, I advise that he try out some "pet" theories. I know of one or two other kindred lines in which I believe I could make some sort of success if I had the time and money to expend. I should sit down and make some sort of analysis of outstanding accomplishments and be honest with myself. Then I should analyze the position I was making application for. If I honestly felt that I were above the average I should not tie myself up to some position that did not compare with the one I had been carrying on successfully for years. If I had to have a position I should accept anything whereby I might make expenses. Many times these small positions lead to better things. After a careful analysis of his talents, an engineer may be surprised to know that he is more qualified as a salesman or an artist than as an operating man.

Birmingham, Ala. GRADY H. EMERSON.

## Often the Fuel Oil Is at Fault

THE AVERAGE DIESEL ENGINEER treats the choice of a lubricating oil as a very serious matter. But I believe many engineers and engines would be better off if equal thought were given to the choice of fuel oil, for my experience has been that efficient results are the result of using not only the proper lubricating oil, but also the proper fuel oil.

We have five diesel engines of the four-stroke-cycle air-injection type, ranging from 165 to 520 horsepower in size.

My first four years' experience with these engines was in the capacity of an operating engineer. During that period various lubricating oils were tried and thrown out of the plant because of excessive carbon and sludge in the crankcase. Attention of the fuel oil was limited to specifying a 26 to 28 gravity and price per gallon delivered. We must have received some good fuel oil during that time, but also a lot that was not so good.

We found that a lubricating oil would show up good for a period and then in a very short time an excessive amount of carbon would appear in the crankcase. Of course the lubricating oil received the blame. Perhaps in some cases the blame was rightly placed, but in other instances the blame should have been directed toward the fuel oil.

During these four years of operating experience we ground valves, cleaned lubricating-oil tubes, fuel-oil tubes, atomizers, needle valves, piston rings and crankcases, of necessity too often. Finally the excessive carbon trouble resulted in the City Council's decision to purchase an oil separator.

Eighteen months ago, I was given charge of the engines. My first move was to recommend the employment of a factory engineer to supervise the complete overhauling of four of our engines.

We found that the cylinders, of an orginal clearance of 0.017 in., showed as much as 0.100 in. clearance at the top, and all the top piston rings were tightly stuck. The piston-oil-cooling tubes were badly clogged with carbon. The main bearings showed clearance up to 0.045 in., instead of the expected 0.010 in. Such a condition was concrete evidence that diesel engines can stand a great deal of punishment and still continue to give service.

After new liners, pistons, main and connecting-rod bearings were installed the engines were again put into operation. Soon we noticed a carbon accumulation building up in the crankcase. My first thought was that the trouble was due to the kind of lubricating oil, but I also noticed that the fuel oil we were getting looked like regular asphalt road oil. Our bids called for 26 to 28 Bé. gravity, and the lowest bidder was getting the business.

We at once changed our bids to call for 28 to 30 gravity with specified limits on asphalt and sulphur content. We also cleaned the engine crankcase at the time the new fuel began to arrive. We then watched the carbon accumulation in the crankcases in order to determine if the change to a better grade of fuel oil decreased the carbon accumulation. If not, then the lubricating oil would have to accept the blame.

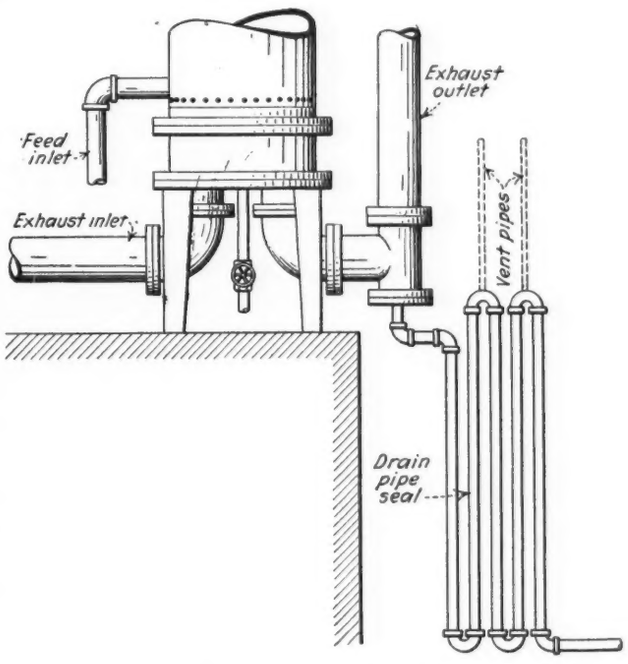
Our first check-up on the crankcase convinced us that there was a big difference in the amount of deposits. Needless to say, we are still using the same grade of fuel oil and the same lubricating oil. We can now run six months, eighteen hours a day, with very little sediment in the crankcase, whereas formerly a month's run resulted in considerable sediment. We now grind the valves about once every six weeks instead of once every week.

In conclusion, I believe that oil companies could better hold the diesel oil business of many plants if they would make and sell a clean, uniform fuel oil of proper viscosity. The combination of a good low-carbon lubricating oil and a clean fuel oil would result in much better operating efficiency, and cleaner crankcases.

Sioux Falls, S. D. SOREN SORENSEN.

## Venting Drain-Pipe Seal

THE PRESSURE OF THE EXHAUST STEAM sent through a closed feed-water heater being quite low, the engineer in charge decided to dispense with the steam trap that was used for discharging the water of condensation and allow the water to drip directly into the sewer. This was done to avoid the annoyance of the trap's becoming clogged by an oily deposit from the condensate, owing to the lack of an effective oil separator in the exhaust line. To insure that no steam should blow through the drain pipe, the engineer devised a sealing arrangement consisting of four vertical lengths of pipe connected together with return bends, as shown in the accompanying sketch. Since the exhaust pressure rarely exceeded 2 lb., he figured that making the seal 4 ft. high would give a sufficient head of water to hold back the steam.




**Air vents necessary in drain pipe seal**

But the drain did not work according to expectations. The drainage water rose almost to the height of the exhaust outlet before the engineer discovered that something was wrong. He concluded that air trapped in pockets somewhere in the seal was the cause of the difficulty. Drilling and tapping the upper return bends to receive the small vent pipes, indicated by the dotted lines in the sketch, removed the trouble.

St. Louis, Mo. A. J. DIXON.

# From Among Readers' Problems

*Conducted by*
L. H. MORRISON

PUMP VALVES—*Why does the water end of a steam-driven pump have several suction valves instead of one large one?* C.C.

It is possible to obtain a greater valve area in a cylinder section if several valves are used. In addition, a single large valve would necessarily weigh several pounds, which would entail considerable inertia and call for a greater pressure drop to cause it to open quickly.

FUSION WELDING PRESSURE — *Is it permissible under the A.S.M.E. Boiler Code to employ fusion-welded seams on a boiler where the weld must take the pressure stress?* C.V.M.

Under existing rules fusion welding of seams is permissible only when some other construction takes the working stresses. It is now proposed that the following paragraphs supersede the present welding requirements, but they have not been definitely placed in the code:

U-67. Pressure vessels may be fabricated by means of fusion-welding provided the construction is in accordance with the requirements for material and design as required by this code and the fusion-welding process used conforms to the specifications for the grade of welding required for each class of vessel.

Fusion-welded pressure vessels shall be classified according to the following schedule. The grade of welding required for each class shall be as indicated.

*Class 1.* All vessels covered by this code, constructed in accordance with the rules for this class, may be used for any purpose. These vessels shall meet Grade A test requirements. The joint efficiency $E$ for this class shall be taken as 90 per cent.

*Class 2.* All vessels covered by this code may be included in this class, excepting those containing lethal gases or lethal liquids and/or those containing liquids operating at a temperature of 250 deg. F. or above (this exemption does not include vessels containing steam only). The maximum pressure at which any vessel in this class may be operated is 400 lb. per square inch, and/or the maximum temperature 730 deg. F., provided the plate thickness as required by the permissible stress allowance does not exceed 1½ in. These vessels shall meet Grade B test requirements. When Grade B test requirements are used, the joint efficiency $E$ shall be taken as 80 per cent.

*Class 3.* All vessels covered by this code, not exceeding ⅝ in. plate thickness and used for the storage of gases or liquids except water at temperatures not exceeding their boiling temperature at atmospheric pressure, and at pressures not to exceed 200 lb. per square inch, and/or not to exceed a temperature of 250 deg. F. may be included in this class, excepting those containing lethal gases or liquids. These vessels shall meet Grade C test requirements. The strengths of the joints shall be calculated on a maximum unit joint working stress ($S \times E$), at right angles to the direction of the joint as follows:

| | Lb. |
|---|---|
| Double-welded butt joints for all joints | 8,000 |
| Single-welded butt joints for girth or head joints | 6,500 |
| Double full-fillet lap welds for girth joints only | 7,000 |
| Spot or intermittent welds for girth or head joints | 5,600 |

For single-welded butt joints for longitudinal joints and for material of thickness of less than ¼ in., the maximum unit joint working stress ($S \times E$) shall not exceed 5,600 lb. per square inch.

The allowable working stresses on the joints in pounds per square inch for different temperatures are given in Par. U-20.

BRITISH THERMAL UNIT—*What is a British thermal unit?* W.W.

The common answer is that the British thermal unit is that amount of heat required to raise 1 lb. of water 1 deg. F. in temperature. Actually, while it is satisfactory for engineering, this answer is not exact. The A.S.M.E. has defined the British thermal unit as 1/180 of the heat required to heat pure water from 32 to 212 deg. F. under atmospheric pressure.

There is, in addition, the value for the B.t.u. derived from the international definition of kilowatt (an international kilowatt is equal to 1.00034 absolute kilowatt.) The international kilowatt-hour is equal to 3,411.5 B.t.u., while the A.S.M.E. kilowatt-hour by definition is equal to 3,413 B.t.u.

OIL ENGINE SMOKES—*We have a 600-hp., four-stroke-cycle, mechanical-injection commonrail, marine diesel. About three months ago the engine began to show a smoky exhaust while going ahead, but when reversed the engine exhaust became clear. To what is the trouble attributable?* H.F.

Mechanical-injection engines employing the commonrail, mechanically controlled, needle-valve injection systems are sensitive as regards the spray-valve cam setting. If the spray valve opens late, the engine will smoke, and if too early, it may pound. Apparently the ahead cam nose has worn enough to make the injection late, while the astern cam nose is still in good shape, due probably to its infrequent use.

## PREVIOUS QUESTIONS DISCUSSED BY READERS

**1.** *IS THERE any advantage possessed by vertical single-acting ammonia compressors compared to horizontal double-acting? Does the variable clearance of the latter make it superior?* A.C.D.

THE VERTICAL AMMONIA COMPRESSOR has inherent advantages. It is recognized to be very efficient and has balanced suction valves of large area. It has a high volumetric efficiency, and hence a high over-all efficiency. The cylinder walls do not tend to wear out of round, and the piston rod and stuffing box are subjected to suction pressure only. It has the disadvantages of requiring high headroom, and difficulty is met with in the adjustment of moving parts.

The horizontal compressor has a low center of gravity and requires less headroom. There is less complication in the operating and the machine is accessible for repair work. This type of compressor has a high mechanical efficiency due to the minimum of rubbing surface, and it can be operated on the wet- or dry-compression principle, whereas vertical compressors cannot handle wet gas.

The variable-clearance effect has gained considerable prestige for the horizontal compressor. It is contended that the horsepower per ton of refrigeration is higher when operating these variable-clearance compressors at reduced capacity, but the amount is trivial. In my opinion, the horizontal ammonia compressor is superior, particularly on the larger installations.

Cumberland, Md. C. N. ALSIP.

ASSUMING that the vertical compressor is of the inclosed type, some of the advantages it has over the double-acting horizontal type are: It is inherently a high-speed machine and can be direct connected to a flywheel-type synchronous motor, which will improve the power factor in plants where there are many induction motors, or it may be connected to standard-speed induction motors by short belt drives; it requires less floor area for a given capacity; the lubrication system is simplified; the rod packing is subject only to the suction pressure and a rotary shaft is easier to maintain packing on than is a reciprocating rod; there are fewer moving parts, consequently fewer wearing surfaces. Vertical compressors can be obtained with variable clearance pockets or apparatus having the same effect, so this doubtful point of superiority of the horizontal machine is nullified. RAY B. WOLF.

San Francisco, Calif.

THE TREND in refrigeration plants is toward high-speed compressors, and therein lies the principal advantage of vertical single-acting compressor. The automobile-engine construction of piston and crosshead in one unit as embodied in the vertical compressor is more suitable for high-speed operation than the separate piston and crosshead of the horizontal type. Not only is the required flywheel effect much reduced, but the cost of the driving motor is materially lower, thereby reducing the capital expenditure. The efficiency of the high-speed motor is also higher and that reduces the electrical energy consumption. The speed range of the majority of present-day vertical compressors lies between 257 and 360 r.p.m., as contrasted with a speed range of 120 to 240 r.p.m. for horizontal compressors.

The vertical type requires less floor space. Variable capacity by means of variable clearance is as applicable to vertical as to horizontal compressors.

OTTO HEIDELBERGER,
Electric Machinery Mfg. Co.
Minneapolis, Minn.

THERE ARE several advantages possessed by the vertical, single-acting ammonia compressor over the horizontal double-acting type; yet there are points in which the latter excels.

One advantage of the vertical machine is that the safety head practically eliminates the danger of breaking a cylinder head. A spring-loaded false head, it will lift when subjected to excessive pressure, due to a large quantity of liquid ammonia coming over or to broken valves and nuts riding on the piston. When one considers the potential hazards of the accidental release of huge quantities of ammonia this safety feature alone is often sufficient to decide in favor of the vertical machine.

Another advantage of the vertical machine is that the packing is subjected to the suction pressure only, and is thus less subject to wear and to leakage. Another advantage is that the cylinder does not tend to wear out of round as it does in the horizontal compressor. Other things being equal, it should run longer without the need of reboring. This tends to keep maintenance costs lower.

As to the advantages of the horizontal machine, it is admitted that it requires less headroom and is therefore better adapted to certain locations. It is also claimed by some to have less friction than the vertical machine; but it is hard to see how there could be any great difference on this point. It is probably true that the horizontal machine is less subject to vibration than the vertical type, as its center of gravity is much closer to the foundation. Since it discharges twice per stroke it does not cause such violent pulsation in the gas lines as does the vertical machine, which might be a decided advantage in certain cases. Another advantage of the horizontal machine is that its working parts are more accessible for inspection and repair.

Variable clearance may be a great convenience in some cases, as it makes it possible to adjust the effective displacement of the machine to load requirements without crippling the efficiency. However, no great economy is realized from this, since more hours operation of the compressor at reduced capacity involves greater power consumption on the part of its auxiliaries, such as condenser water pump and exciter. This extra power usually more or less offsets that saved by adjusting the clearance on the compressor. The convenience of this feature, however, makes it desirable in some cases.

Beaumont, Texas. M. F. KNOY.

## A Question for Our Readers

*A BOILER with a powdered-coal furnace operating at a maximum hourly evaporation of 12 lb. water per square foot of heating surface has four safety valves on the boiler proper, set to operate at 600, 612, 615 and 618 lb. There is also one safety valve on the superheater. At what boiler pressure should the superheater safety valve be set to operate? Why?* J.P.M.

Suitable answers will be paid for[1] and published in the July 14 number.

[1]As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.)

Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkeisen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehling's *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Poper Plant Lubrication,* Moyer and Fritz' *Refrigeration;* Rietschel-Brabbee's *Heating and Ventilation;* Annett's *Electric Elevators.*

*2. WHAT IS the smallest amount of heat needed per kilowatt output by any form of heat engine?* L.H.

A KILOWATT is 1.34 hp. A horsepower is the rate at which work is done. One horsepower is 33,000 ft.-lb. per minute, or 1,980,000 ft.-lb. per hour. Since 1 B.t.u. is 778 ft.-lb. a horsepower is $\frac{1,980,000}{778}$ or 2,545 B.t.u. per hour. $1.34 \times 2,545 = 3,412$, or 1 kw. is 3,412 B.t.u. per hour.

Any heat engine is considered perfect when it operates with an efficiency equal to that of its ideal cycle. For the steam plant, the Rankine Cycle, or a modification of it, is used as an ideal; in the diesel plant the cycle outlined by Dr. Diesel is used. The smallest amount of heat needed per hour to produce a kilowatt in a perfect steam plant varies from about two and one-half times the theoretical 3,412 B.t.u. per hour to considerably higher values, depending upon the initial condition of the steam and its exhaust pressure. The amount needed in the perfect internal-combustion engine varies from about two times the theoretical 3,412 to higher values, depending on the compression pressure and on the percentage excess air supplied.

The actual plant must be supplied with more heat than the ideal plant, because of the impossibility of attaining the ideal cycle.

The most efficient steam plant will produce a kilowatt for each 12,500 B.t.u. supplied per hour in the fuel. The mercury steam plant will produc a kilowatt for about 10,000 B.t.u. per hour, while a diesel plant will produce a kilowatt with approximately the same heat consumption. W. H. MARTIN,
*Professor of Heat Engineering,*
Oregon State Agricultural College.
Corvallis, Ore.

# A.S.M.E. Regional Meeting Held at Hartford

ALTHOUGH the attendance was small, the program of well-chosen papers and the arrangements made by the local committee for trips and entertainment made the Hartford meeting of the A.S.M.E. last week distinctly worth while. There were four papers dealing with power problems and several others of general interest to power men.

G. B. Gould's paper on "How Coal Market Values Are Related to Steam Plant Design and Operation" offered helpful suggestions to the purchaser of coal in the New England and Middle Atlantic states and showed how essential it is for the differences in value due to size and other characteristics of coal to be taken into consideration by those who design steam plants to the end that dollar efficiency, rather than mere thermal efficiency be attained.

Data were presented to show how the smaller sizes, which in general yield the greatest energy value per dollar, constitute but a comparatively small part of the total output. These sizes now sell at prices disproportionately low, but a comparatively small change in demand might equalize the cost of energy between the slack and the next largest size. Market preferences have placed a premium on other physical characteristics, such as high fusing point of the ash, low volatile, etc., which are qualities found in a small proportion of the total production. The composite effect of these preferences has created price differentials out of line with energy values. These preferences are due to limitations placed upon coal selection by the design and operating requirements of existing plants. Therefore, the differences in the basic cost of energy in the form of coal constitute a factor that must be considered in appraising the economic worth of a steam plant, independent of its efficiency rating; and in the design of new plants probable future trends, as between market values and coal characteristics, must be considered.

Mr. Gould's paper prompted a general discussion of fuels of all kinds, domestic as well as steaming, which took the form of an experience meeting.

### Experiences With Radiant Superheaters

At the power session on Tuesday morning, M. K. Drewry related the seven years' experience with radiant superheaters at Lakeside station, Milwaukee. This had definitely shown the superiority of the light-weight round-tube design, over the heavy rectangular elements. With this type of elements a starting problem was encountered, because there was scarcely no storage of heat in the metal and, with no steam available to cool them, overheating was likely to occur. This problem was finally met by setting a definite coal-feed rate to keep the flame temperature at the superheater under 1,000 deg. until header pressure was reached. This procedure requires about four hours for starting a boiler.

Contrary to expectations, these carbon-steel tubes lasted over a year without a single failure. Half of them are still in service after three and one-half years' operation and 800 similar tubes of slightly better metal have been in service three years with only two failures. Temperature measurements indicate that these tubes operate at not exceeding 950 degrees.

It was found that creep occurred directly in proportion to the operating hours, the greatest increase in circumference being at the middle of the element. Since the first element reached 29 per cent enlargement before failure, it is reasonable to set 20 per cent maximum creep as practical for most installations, providing oxidation does not cause premature failure. Dangers from creep are greatly lessened by the fact that the time of ultimate failure can be prophesied with accuracy.

In conclusion Mr. Drewry expressed the opinion that high pressures are particularly adapted for radiant superheaters, as pressure stresses appear to be a minor factor in causing creep. Moreover, they have the incidental merit of facilitating furnace cooling by covering side walls that are not as easily water-cooled as front and rear walls, of reducing total heating surface costs because of better heat-transfer efficiency, and of allowing lower $CO_2$ without excessive steam temperatures when burning unusually poor coals. Very high heat-transfer rates and quick starting preclude their use.

In discussing the paper, George Orrok expressed preference for the small thin-walled tube and suggested the desirability of making the tube thickness such that the pressure stress and the heat stress would be equal. This, however, would bring the wall thickness below that prescribed by the Boiler Code, which is intended to cover all cases. He believed 20 per cent increase in diameter due to creep to be common and pointed out that the most severe condition is where, through flame impingement and oxidation, the tube bulges and cracks. Such failures, however, while they may put out the fire, are not serious, as the emission of steam cools the metal and the tube does not burst. It is a question whether a thin tube of open-hearth steel lasting 3 to 3½ years is better than one of alloy steel lasting twice as long but costing double the price.

H. J. Kerr was of the opinion that the experiences at Milwaukee were not applicable to all conditions; this being true especially as to starting procedure. The most critical zone for creep is at low ratings. Low alloy materials have superior creep characteristics up to 1,000 deg., but show no gain over carbon steel above this. Above 950 deg. dissociation of the steam begins to take place rapidly and oxidization occurs. Control of steam temperature by desuperheating he believed to be the most "foolproof" method yet developed.

### Load Deflection of Large Plain, Corrugated and Creased Pipe Bends

Limitations placed on the design of main steam piping for unit No. 6 at the Marysville plant of the Detroit Edison Company made it desirable to use piping of elements having much more than customary flexibility, and it was decided to resort to corrugated pipe. In the absence of accurate test data as to the relative flexibility of corrugated bends and plain bends it was decided to check calculations by actual test and to include the creased bend as well as a short-radius forged elbow having a tangent welded to each end. The results were reported in a paper by E. T. Cope and E. A. Wert, both of the Detroit Edison Company.

In all cases the flexibility of the pipe as shown by test was greater than the calculated flexibility. The plain pipe bend made up of a forged quarter bend having a tangent welded to each end showed the same characteristics as the bend of larger radius. Expressing as a ratio the relation between flexibility obtained by test of such corrugated and creased pipe and that obtained by calculation of a plain pipe of the same major dimensions[1], the following was obtained:

| Kind of Pipe | Ratio |
|---|---|
| 14-in., 90-deg. corrugated bend | 2.2 |
| 14-in., 90-deg. corrugated bend | 1.8 |
| 14-in., 90-deg. creased bend | 1.3 |
| 14-in., 90-deg. creased bend, short radius | 1.3 |
| 14-in. expansion U-bend | 2.8 |
| 10-in. U-bend | 4.5 |
| 14-in. corrugated tangent | 5.1 |
| 14-in. corrugated tangent in torsion | 0.9 |

In the discussion it was pointed out that when the manufacture of creased

[1] By "plain pipe of the same major dimensions" is meant a smooth pipe having the same diameter and wall thickness as that used in making the bend under test. The center-to-face dimensions of the plain pipe bend and the bend under test are assumed to be the same.

bends was first undertaken in this country some difficulty was encountered because our standards are quite different from the thin-walled bends permitted in Germany. The opinion was expressed that creased bends are better adapted to turbines than corrugated bends and that the pressure drop through the latter is 2½ times that through the former. Another speaker, referring to a former paper by Mr. Spring, indicated that plain bends are more flexible than creased bends. W. E. Kern stated that Tube Turns and 90-deg. creased bends are equally flexible.

The third paper at the power session was on "Decomposition of Sodium Carbonate in Steam Boilers," by R. F. Larson, of the University of Illinois. In the absence of the author the paper was read by title only. The author's conclusions were that the principle controlling factor in the establishment of the extent of decomposition of sodium carbonate in a boiler water is the partial pressure of the carbon dioxide in the vapor phase. This, in turn, depends on the amount and availability of the potential carbon dioxide contained in the feed water.

The effect of boiler operating pressure decreases with a decrease in carbonate content of the feed water.

For the range of steaming rates covered in the tests, boiler rating does not appear to be a factor governing the extent of decomposition.

The total alkalinity existing in a boiler water is a factor, the extent of decomposition decreasing with increase in boiler water alkalinity.

### The Engineer's Opportunity in Public Life

One of the principal addresses during the meeting was by Senator Bingham of Connecticut, who spoke on the engineer in public life. "From the standpoint of a student of our political institutions, engineering has its dangers, as well as its duties," said the senator. "The engineer is accustomed to dealing with physical laws which always operate in exactly the same manner. The body politic is not a machine, however. The laws under which it operates are frequently so affected by unseen causes that they appear to fail at the moment you expect them to succeed.

"When an engineer contemplates public life he is likely to deplore waste and seek efficiency. Under a benevolent despotism there would be minimum waste, but there would be less development of individual initiative and less happiness coming from liberty and freedom.

"If the engineer be careful not to demand more laws but better ones, and will be careful to preserve the freedom of the individual, he can be of great value to the state. However, he must not assume that a state can be treated like a machine."

At the banquet on Tuesday evening President Roy V. Wright spoke on technological unemployment, and outlined the study that has recently been undertaken by a committee of the American Engineering Council to investigate the subject.

▼ ▼ ▼

# GRINDABILITY OF COAL

THE GENERAL use of pulverized coal in power plants has added pulverizers to the list of equipment to be tested. Up to the present pulverizer tests have been incomplete and unsatisfactory because there was no method of determining the grinding characteristics of coal.

If accurate knowledge of the grindability and the abrasive qualities of the coal could be determined as easily as the fusing temperature, it would be of considerable help to the coal buyer. Thus the need for a standard grindability method has been felt by both manufacturers and users of pulverizing equipment.

### Rittinger's Law of Grinding

Rittinger's Law of grinding work, which states that the work done in grinding is proportional to the new surface produced, is generally accepted as being approximately correct. If one considers a 1-in. cube split into eight ½-in. cubes, each of these small cubes will have three new faces in addition to the three old ones, or the surface of the ½-in. cubes is just double the original surface. Rettinger's Law states that the work done in grinding is proportional to the reciprocal of the diameter of the particles.

The method of determining grindability may be outlined as follows:

1. Prepare the coal sample so that all particles are of practically the same diameter.
2. Subject this sample to a definite process of pulverization.
3. Screen this partly pulverized samplet and determine the increased surface produced.
4. Based on Rittinger's Law, the final surface of the sample is obtained by applying constants proportional to the reciprocal of the diameters of the particles. The new surface produced is obtained by subtracting the original surface.
5. The relative grindability is obtained by comparing the new surface to that obtained in a similar way on a coal selected as a basis for comparison.

**Pulverizer capacity depends as much on the fuel as on the design and construction of the unit. From this fact arises the insistent demand for a dependable grindability test. Such a test was described by R. M. Hardgrove, Fuller Lehigh Company, at the Birmingham A.S.M.E. meeting in April. This is an abstract.**

A sample prepared so that all will pass through a 16-mesh screen and all be held on a 30-mesh screen seems to satisfy the requirements the best. All of the work reported in this paper was done on samples sized between those limits.

In preparing the sample it is crushed in a coffee mill, which produces the least amount of fines, until all will pass through a 16-mesh screen, after which the material finer than 30-mesh is screened out and rejected. A definite weight is then selected from this sample.

### The Test Mill

Fig. 1 illustrates the ball mill used in the later work. The eight 1-in. balls roll on a stationary ring and are driven from above by a spring-loaded rotating plate, at a speed of 21 r.p.m. Deadweights were used during some of the work and gave results equal to those obtained with the springs. Several other minor features are being improved upon.

### Somerset Coal Used as Standard

In selecting a coal of "100 per cent grindability," a standard with which all others could be compared, it was found that the semi-bituminous coals from the New River and Pocahontas fields in West Virginia and from the Upper Kittaning seam in Somerset and Cambria Counties, Pennsylvania, had about the same grindability. Moreover, these were the easiest-grinding coals to be found in this country. It seemed logical that one of these should be chosen, and the most convenient one was the coal from Somerset County, Pennsylvania.

It is quite evident that in order to establish a standard method various laboratories must use the same size of sample, the same number of revolutions, the same speed, the same method of screening and calculation, and preferably the same type and size of machine. [Readers interested in these details are referred to extensive comments in the original paper.—Editor.]

The establishment of a definite grind-

# GRINDABILITY OF REPRESENTATIVE COALS OF THE UNITED STATES

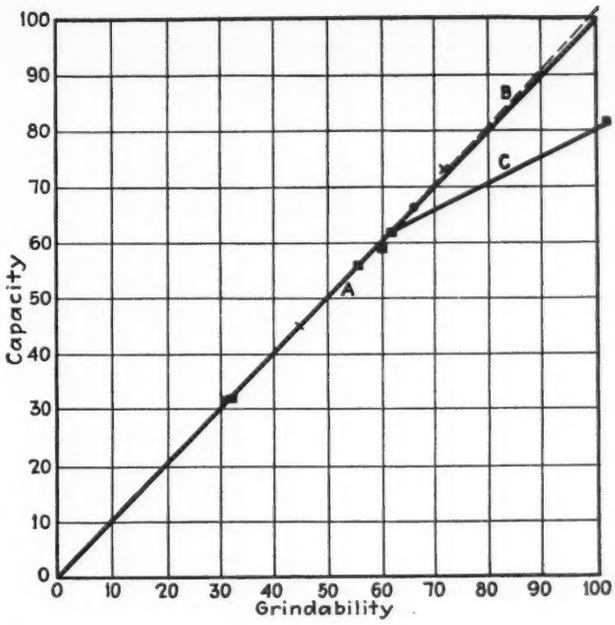
| State | District | County | Seam | Number of Samples | Volatile Matter | Fixed Carbon | Ash | Fusing Temperature — Initial Def. | Fusing Temp. | Fluid Temp. | Grindability — Max. | Min. | Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | Cahaba | St. Clair | Harkness | 1 | 32.90 | 57.10 | 10.00 | .... | 2323 | .... | .. | .. | 62 |
| | Cahaba | St. Clair | Helena | 1 | 35.10 | 59.10 | 5.80 | .... | 2340 | .... | .. | .. | 49 |
| | Cahaba | St. Clair | Harkness | 1 | 32.55 | 54.55 | 12.90 | .... | .... | .... | .. | .. | 58 |
| | Warrior River | Jefferson | Pratt | 1 | 29.45 | 59.60 | 10.95 | .... | .... | .... | .. | .. | 72 |
| | Warrior River | Jefferson | Mary Lee | 1 | 28.80 | 59.00 | 12.20 | .... | .... | .... | .. | .. | 72 |
| Colorado | Denver | Weld | ..... | 3 | 51.70 | 36.00 | 12.23 | 2232 | 2306 | 2507 | 41 | 37 | 39 |
| | Denver | Weld | ..... | 2 | 48.60 | 45.80 | 5.57 | 2005 | 2055 | 2195 | 49 | 46 | 48 |
| | Denver | Weld | ..... | 1 | 57.90 | 32.85 | 9.25 | 2170 | 2230 | 2475 | .. | .. | 41 |
| Illinois | Fulton County | Fulton | No. 5 | 1 | 31.10 | 40.05 | 18.65 | .... | 1975 | .... | .. | .. | 66 |
| | Central Illinois | Christian | No. 6 | 8 | 37.70 | 48.68 | 13.80 | 1925 | 2050 | 2100 | 59 | 44 | 55 |
| | Danville | Vermilion | No. 6 | 8 | 35.46 | 50.75 | 13.70 | 2010 | 2250 | 2375 | 77 | 60 | 68 |
| | Danville | Vermilion | No. 6 | 4 | 34.93 | 52.5 | 12.30 | 2138 | 2260 | 2360 | 59 | 53 | 57 |
| | Springfield | Sangamon | No. 5 | 26 | 37.75 | 46.69 | 15.22 | 1975 | 2025 | 2205 | 71 | 51 | 61 |
| | Belleville | St. Clair | No. 6 | 1 | 34.87 | 42.02 | 13.57 | .... | 2095 | .... | .. | .. | 61 |
| | Saline-Gallatin | Saline | No. 5 | 4 | 35.00 | 51.05 | 8.47 | 2120 | 2225 | 2350 | 63 | 53 | 56 |
| | Murphysboro | Jackson | No. 2 | 2 | 41.00 | 51.70 | 7.30 | .... | 2100 | .... | 74 | 75 | 74 |
| Indiana | Sullivan-Linton | Sullivan | No. 5 | 2 | 39.25 | 44.00 | 11.75 | 2007 | 2095 | 2187 | 58 | 57 | 58 |
| | Princeton-Ayrshire | Gibson | No. 5 | 2 | 38.02 | 47.20 | 9.90 | 2095 | 2240 | 2435 | 73 | 73 | 73 |
| Kentucky | Elkhorn | Letcher | Elkhorn | 2 | 36.45 | 55.22 | 8.32 | .... | 2892 | .... | 54 | 55 | 55 |
| | Elkhorn | Letcher | Hazard | 1 | 35.55 | 48.05 | 16.40 | .... | 2690 | .... | .. | .. | 62 |
| | Hazard | Perry | Hazard No. 4 | 1 | 34.95 | 57.55 | 7.50 | .... | 2720 | .... | .. | .. | 48 |
| Michigan | Saginaw | Saginaw | Saginaw | 1 | 37.65 | 52.70 | 9.65 | .... | 2220 | .... | .. | .. | 50 |
| North Dakota | ..... | Ward | ..... | 1 | 61.70 | 32.90 | 5.40 | .... | 2360 | .... | .. | .. | 50 |
| Ohio | Belmont-Pgh | Belmont | Pgh. No. 8 | 1 | 42.40 | 50.60 | 7.00 | .... | 2120 | .... | .. | .. | 57 |
| | Belmont-Pgh | Belmont | Pgh. No. 8 | 1 | 42.49 | 51.02 | 6.49 | 2220 | 2310 | 2395 | .. | .. | 64 |
| | Belmont-Pgh | Belmont | Pgh. No. 8 | 1 | 34.80 | 54.05 | 11.15 | .... | 2120 | .... | .. | .. | 54 |
| | Belmont-Pgh | Belmont | Pgh. No. 8 | 1 | 40.80 | 50.60 | 8.60 | .... | 2070 | .... | .. | .. | 63 |
| | Belmont-Pgh | Belmont | Pgh. No. 8 | 1 | 39.05 | 51.05 | 9.90 | .... | 2070 | .... | .. | .. | 49 |
| | Belmont-Pgh | Belmont | Pgh. No. 8 | 1 | 37.75 | 51.25 | 11.00 | .... | 2100 | .... | .. | .. | 62 |
| | Belmont-Pgh | Jefferson | Pgh. No. 8 | 1 | 37.10 | 58.60 | 4.90 | .... | 2235 | .... | .. | .. | 49 |
| | Cambridge | Guernsey | Upper Freeport | 1 | 34.55 | 57.55 | 7.90 | .... | 2410 | .... | .. | .. | 49 |
| | Cambridge | Guernsey | Upper Freeport | 1 | 32.15 | 55.05 | 12.80 | .... | 2240 | .... | .. | .. | 38 |
| Oklahoma | McAlester | Pittsburgh | Wilburton | 10 | 30.60 | 55.30 | 14.00 | 2075 | 2115 | 2295 | 67 | 47 | 57 |
| Pa. Anth. | Wilkes-Barre | Luzerne | ..... | 1 | 5.63 | 88.40 | 5.95 | 3000+ | .... | .... | .. | .. | 24 |
| | Wilkes-Barre | Luzerne | ..... | 1 | 5.95 | 87.45 | 6.60 | 3000+ | .... | .... | .. | .. | 21 |
| | Black Creek | Luzerne | ..... | 2 | 5.35 | 65.03 | 29.62 | 2890 | 2960 | 3000+ | .. | .. | 36 |
| | Black Creek | Luzerne | | 1 | 5.10 | 82.40 | 12.50 | 3000+ | .... | .... | .. | .. | 26 |
| | Black Creek | Luzerne | ..... | 2 | 5.22 | 81.85 | 12.92 | 3000+ | .... | .... | .. | .. | 29 |
| | Hazleton | Luzerne | ..... | 1 | 5.65 | 79.60 | 14.75 | 2935 | 3000+ | .... | .. | .. | 24 |
| | Panther Creek | Carbon | ..... | 1 | 4.70 | 81.20 | 14.10 | 2885 | 2950 | 3000+ | .. | .. | 30 |
| | Panther Creek | Schuylkill | ..... | 1 | 6.75 | 83.90 | 9.35 | 2875 | 2950 | 3000+ | .. | .. | 30 |
| | West Schuylkill | Schuylkill | ..... | 3 | ..... | ..... | ..... | .... | .... | .... | 59 | 40 | 52 |
| | West Schuylkill | Schuylkill | ..... | 4 | 5.50 | 79.80 | 13.20 | .... | .... | .... | 46 | 38 | 42 |
| | West Schuylkill | Schuylkill | ..... | 3 | 4.10 | 83.10 | 10.60 | .... | .... | .... | 31 | 23 | 27 |
| | West Schuylkill | Schuylkill | ..... | 3 | ..... | ..... | ..... | .... | .... | .... | 47 | 39 | 43 |
| | West Schuylkill | Schuylkill | ..... | 1 | 6.39 | 77.93 | 15.68 | .... | .... | .... | .. | .. | 35 |
| | West Schuylkill | Schuylkill | ..... | 1 | 5.49 | 67.25 | 23.56 | .... | .... | .... | .. | .. | 46 |
| | West Schuylkill | Schuylkill | ..... | 1 | 4.90 | 83.10 | 10.80 | .... | .... | .... | .. | .. | 39 |
| | Lorberry | Schuylkill | | 1 | ..... | ..... | ..... | .... | .... | .... | .. | .. | 37 |
| Pa. Bit. | Clearfield | Clearfield | Upper Kittanning | 2 | 21.87 | 63.87 | 14.25 | 2580 | 2652 | 2725 | 92 | 83 | 88 |
| | Low Grade | Clarion | Brookville | 1 | 31.55 | 52.70 | 15.75 | .... | 2540 | .... | .. | .. | 53 |
| | Shawmut | Elk | Kittanning | 1 | 28.55 | 61.50 | 9.95 | 2140 | 2460 | 2585 | .. | .. | 73 |
| | Indiana | Indiana | Kittanning | 21 | 26.80 | 63.42 | 9.85 | .... | 2158 | .... | 119 | 99 | 106 |
| | Johnstown | Cambria | Freeport | 2 | 22.00 | 71.30 | 6.65 | 2420 | 2535 | 2665 | 123 | 115 | 119 |
| | Johnstown | Cambria | Kittanning | 1 | 20.65 | 64.10 | 7.25 | .... | 2340 | .... | .. | .. | 101 |
| | Johnstown | Cambria | Miller | 1 | 21.40 | 73.85 | 4.75 | 2570 | 2680 | 2800 | .. | .. | 111 |
| | Somerset (a) | Somerset | Upper Kittanning | 100 | 17.45 | 71.88 | 9.67 | 2750 | 2860 | 2950 | 103 | 98 | 100 |
| | Youghiogheny | Westmoreland | Pittsburgh | 1 | 36.10 | 56.75 | 7.75 | .... | 2070 | .... | .. | .. | 53 |
| | Pittsburgh | Allegheny | Pittsburgh | 1 | 37.25 | 55.14 | 7.61 | .... | 2380 | .... | .. | .. | 54 |
| | Pittsburgh | Fayette | Pittsburgh | 1 | 33.45 | 54.85 | 11.70 | .... | 2585 | .... | .. | .. | 59 |
| | Pittsburgh | Washington | Pittsburgh | 1 | 33.61 | 57.34 | 9.05 | .... | 2646 | .... | .. | .. | 63 |
| | Pittsburgh | Westmoreland | Pittsburgh | 1 | 35.34 | 58.36 | 6.30 | .... | 2460 | .... | .. | .. | 58 |
| Texas | Eagle Pass | Maverick | Eagle Pass | 3 | 24.10 | 51.13 | 26.71 | .... | 2950 | .... | 104 | 82 | 91 |
| | Laredo | Webb | San Pedro | 3 | 45.84 | 36.31 | 17.85 | .... | 2138 | .... | 39 | 32 | 36 |
| Tennessee | ..... | Overton | Wiler | 1 | 33.70 | 53.40 | 12.90 | .... | 2625 | .... | .. | .. | 64 |
| Utah | ..... | Carbon | Mesa Verde | 1 | 42.00 | 51.10 | 6.90 | .... | 2305 | .... | .. | .. | 46 |
| | ..... | King | Hiawatha | 1 | 43.05 | 49.45 | 7.50 | 2460 | 2570 | 2690 | .. | .. | 46 |
| Washington | ..... | King | McKay | 2 | 41.70 | 48.5 | 9.82 | .... | 2580 | .... | 41 | 39 | 40 |
| | ..... | Pierce | No. 2 | 2 | 32.95 | 55.5 | 11.55 | .... | 2752 | .... | 68 | 67 | 68 |
| | ..... | Pierce | No. 2 | 2 | 29.05 | 55.30 | 15.70 | .... | 2662 | .... | 87 | 67 | 77 |
| | ..... | Pierce | No. 3 | 1 | 21.20 | 60.30 | 18.50 | .... | 2775 | .... | .. | .. | 101 |
| | ..... | Thurston | ..... | 1 | 19.75 | 70.65 | 9.60 | .... | 2425 | .... | .. | .. | 68 |
| West Virginia | Fairmont | Harrison | Pittsburgh | 1 | 39.60 | 53.45 | 6.95 | .... | 2200 | .... | .. | .. | 67 |
| | Fairmont | Marion | Pittsburgh | 2 | 39.82 | 52.85 | 7.32 | 2085 | 2160 | 2345 | 67 | 67 | 67 |
| | Fairmont | Marion | Pittsburgh | 1 | 39.10 | 56.60 | 4.30 | 2330 | 2425 | 2540 | .. | .. | 49 |
| | Fairmont | Marion | Pittsburgh | 1 | 37.25 | 58.24 | 4.50 | 2410 | 2520 | 2640 | .. | .. | 52 |
| | Fairmont | Marion | Pittsburgh | 1 | 35.41 | 54.99 | 9.60 | 2160 | 2295 | 2395 | .. | .. | 59 |
| | Fairmont | Marion | Pittsburgh | 1 | 41.14 | 53.44 | 6.40 | 2030 | 2210 | 2360 | .. | .. | 49 |
| | Fairmont | Monongalia | Pittsburgh | 1 | 37.25 | 53.25 | 9.50 | .... | 2320 | .... | .. | .. | 59 |
| | Fairmont | Monongalia | Pittsburgh | 1 | 38.90 | 53.05 | 8.05 | .... | 2220 | .... | .. | .. | 59 |
| | Preston-Taylor | Preston | Freeport | 1 | 28.55 | 60.40 | 11.05 | .... | 2800 | .... | .. | .. | 63 |
| | New River | Fayette | Sewell | 2 | 27.40 | 68.30 | 4.30 | .... | 2817 | .... | 94 | 90 | 92 |
| | New River | Fayette | Sewell | 1 | 22.65 | 72.45 | 5.30 | 2240 | 2380 | 2460 | .. | .. | 109 |
| | New River | Green Briar | Sewell | 1 | 26.60 | 69.85 | 3.55 | .... | 2305 | .... | .. | .. | 99 |
| | Winding Gulf | Raleigh | Dorothy | 3 | 35.25 | 58.70 | 6.05 | 2775 | 2836 | 2900 | 42 | 40 | 41 |
| | Kanawha | Kanawha | Cedar Grove | 2 | 34.77 | 52.80 | 12.42 | .... | 2740 | .... | 42 | 39 | 41 |
| | Kanawha | Kanawha | Coalburg | 2 | 35.40 | 52.47 | 12.12 | .... | 2813 | .... | 45 | 42 | 44 |
| | Kanawha | Kanawha | Coalburg | 2 | 34.90 | 54.97 | 10.15 | .... | 2960 | .... | 47 | 39 | 43 |
| | Kanawha | Kanawha | Winifrede | 2 | 35.15 | 55.12 | 9.72 | .... | 3000+ | .... | 38 | 36 | 37 |
| | Pocahontas | Mercer | Orista No. 3 | 1 | 17.10 | 72.18 | 6.34 | .... | .... | .... | .. | .. | 105 |
| | Pocahontas | Mercer | Pocahontas No. 3 | 3 | 22.27 | 72.17 | 5.55 | 2277 | 2387 | 2523 | 119 | 108 | 113 |
| | Pocahontas | Mercer | Pocahontas No. 3 | 2 | 21.25 | 73.35 | 5.35 | 2268 | 2425 | 2552 | 109 | 104 | 107 |
| | Pocahontas | Mercer | Pocahontas No. 3 | 2 | 18.11 | 71.25 | 9.62 | 2620 | 2740 | 2718 | 96 | 90 | 93 |
| | Logan | Logan | Eagle | 2 | 34.87 | 61.82 | 3.27 | .... | 2657 | .... | 52 | 46 | 49 |
| | Logan | Logan | Island Creek | 2 | 34.85 | 58.49 | 6.66 | .... | 2482 | .... | 49 | 52 | 51 |
| | Coal River | Boone | Dorothy | 2 | 36.75 | 59.50 | 3.75 | 2725 | 2800 | 2890 | 37 | 36 | 37 |

(a) This is 100-grindability coal, used as a basis of comparison.

ability scale that is in general use will be of great value even though the numbers of the scale have no exact relation. However, if this scale can bear some definite relation to the capacity of the mill it will greatly increase the field of its usefulness.

In Fig. 2 are plotted the relative capacities obtained by grinding material of various grindabilities on the same pulverizer. *A* represents three points obtained with different materials in a closed-circuit grinding system with relatively coarse grinding. The material being ground was cushioned very little by fine products and therefore can be said to follow its true grindability quite closely. Points on the line *B* were obtained by grinding coal in a tube mill equipped with an external classifier where a high recirculating load was used, which means that the grinding parts were scavenged quite completely. This also checks the theoretical curve. Curve *C* represents five points obtained from air-swept mills with internal classifiers.

**Fig. 2 (Right) — Curve shows that mill capacity is inversely proportional to grindability, indicating the practical usefulness of the test**



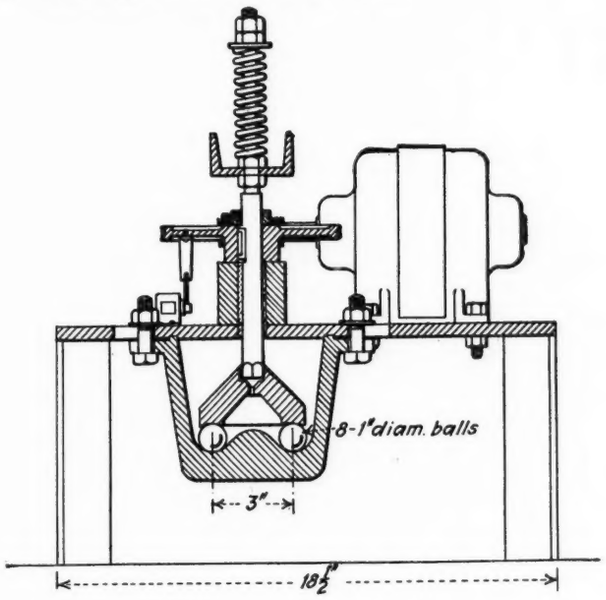




**Fig. 1 (Left) — Ball-mill type of grindability machine finally adopted for coal testing. Dead weight loading was equally satisfactory**

On the basis of Fig. 2, it seems that the scale established is a very reasonable one, even though it requires individual interpretation with different types of pulverizing mills.

Since a mill usually takes about the same power when it is fully loaded, irrespective of how many tons it is producing, it follows that the power per ton is inversely proportional to the maximum capacity, and therefore inversely proportional to the grindability of the material.

During the four years wherein this method has been in use over 2,000 samples have been tested. In the accompanying table are shown the grindabilities of representative coals from various parts of the United States.

### Grindability Related to Volatile

In general there is a relation between the volatile content of the coal and its grindability. Coals between 16 and 28 per cent volatile are usually of high grindability, and this decreases as the volatile increases, but there are so many exceptions to this trend that determination of volatile is not a definite guide to grindability. The Pennsylvania anthracite show a remarkably uniform variation from very hard in the eastern end of the field to quite soft in the western end.

▼ ▼ ▼

## Cost of Fifteen Mile Falls Within 0.5% of Estimates

The final check-up of the cost of constructing the new 215,000 hp. Fifteen Mile Falls hydro-electric plant of New England Power Association, shows that the total cost is within one-half of 1 per cent of the preliminary estimate. Although many unanticipated difficulties were encountered during construction, such as ice jams during the first winter and the premature closing of a bypass through the fall of a water gate, they were offset by economies worked out in other directions, chiefly in the erection of the 126-mile 220,000 volt transmission line.

Necessity for an accurate estimate of ultimate cost is indicated by the fact that New England Power Association's long-term contract with The Edison Electric Illuminating Company of Boston for about one-half the output of the Fifteen Mile Falls plant was negotiated on the basis of the original estimates.

The close approximation of ultimate cost of the Fifteen Mile Falls plant was paralleled in the Gatineau River construction program of Gatineau Power Company, another subsidiary of International Hydro-Electric system. Extending over a period of three years and ranking as one of the great engineering achievements of history, the system of hydro-electric plants built on that river came within 1 per cent of original estimates. Included in that program were three hydro-electric plants designed for an aggregate installation of 562,000 hp., of which 436,000 hp. was then installed, a storage reservoir one-sixth greater than the famous Assuan reservoir on the Nile, and a considerable mileage of high-tension transmission lines. Deliveries of primary power to the Hydro-Electric Power Commission of Ontario alone from these Gatineau River plants now total 288,000 hp., and on Oct. 1 will be increased to 304,000 horsepower.

## British Columbia Adopts Uniform Boiler Rules

British Columbia has joined the other Canadian provinces in adopting the uniform boiler-inspection regulations, according to an announcement of the British Columbia Workmen's Compensation Board.

These new regulations were drafted at a meeting of the chief boiler inspectors of the Dominion in Calgary, Alberta, a year ago, and cover construction, operation and inspection of all boilers and pressure vessels in the province, while one condemns any flat surface on boiler lap seams.

It was reported that ten inspectors cover the province, and all boilers are inspected at least once a year. In the last three years 32 boilers have been condemned, while it is stated that not a single death or any destruction of property has been caused by a boiler explosion during the past 30 years.

# WHAT'S NEW IN PLANT EQUIPMENT

## Jet Pipe Used in Hydraulic Control of Boilers

IN EUROPE the jet pipe principle of automatic control devised by Askania Werke, A. G., of Berlin, has been used for many years to regulate gas pressures. More recently the system has been adapted to the control of boiler units, prime movers and other equipment of the power plant. About the first of the year the American rights were taken over by H. A. Brassert & Company, Chicago, Ill.

In its simplest form the control system consists of a pump supplying oil under pressure to a jet pipe arranged to oscillate on a hollow pivot through which it receives the oil supply. Linked to a corrugated-metal diaphragm counterbalanced by a weight on one side and to an adjustable spring on the other side, the jet pipe moves according to the variation in pressure of the medium under control. In the present case, Fig. 1, it is steam in a pipe line. In the casing facing the jet-pipe nozzle two closely adjacent orifices of the same internal diameter as the nozzle are connected to opposing ends of a regulating cylinder that operates the controlled member, such as a damper or valve. In the central position of the jet pipe the oil flows from the nozzle, striking equally on both orifices, so that pressures on both sides of the piston are equal. If the steam pressure increases, the diaphragm pushes the jet pipe to the left against the action of the spring, so that more of the oil enters the orifice on that side. By increasing the pressure on one side of the piston and decreasing it on the other the piston moves to close the valve in the pipe line until a balance is again established. With a drop in pressure, movements of jet and valve are in opposite directions.

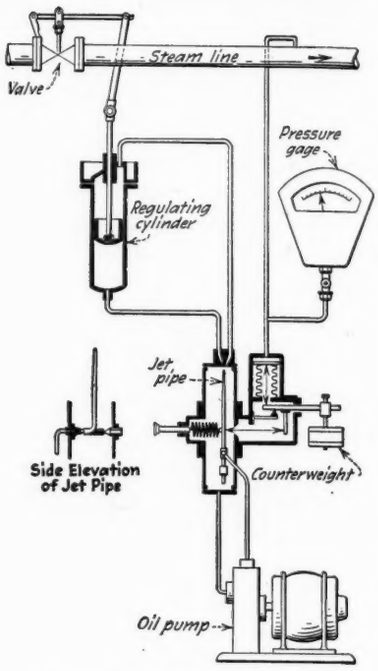
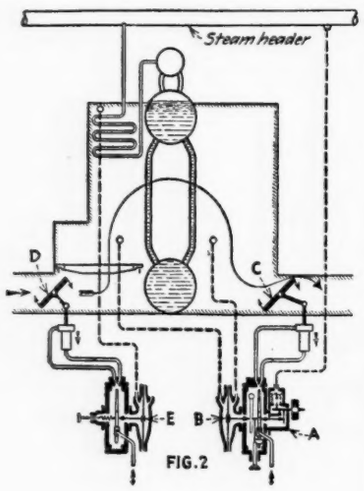
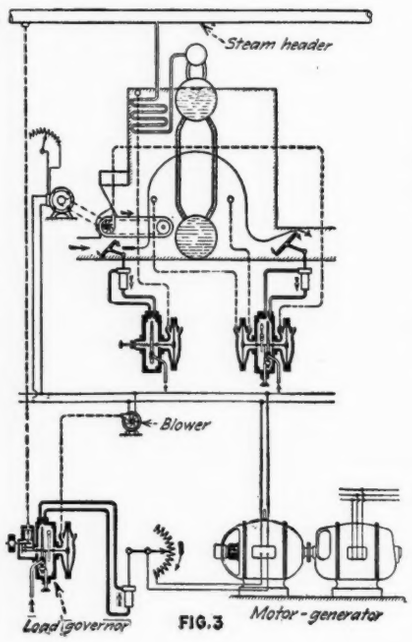
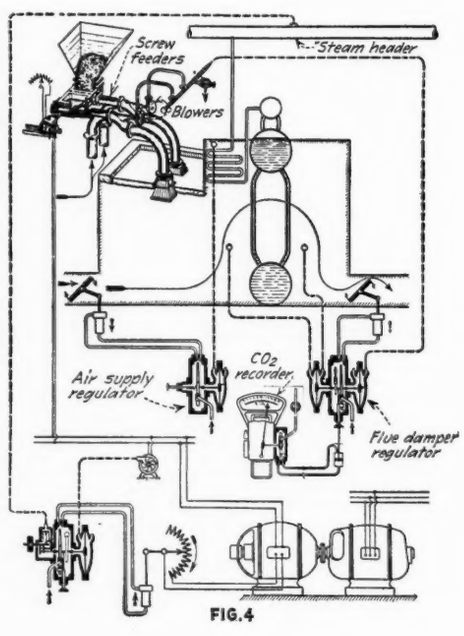



**Fig. 1—Steam pressure control by jet pipe principle**

In Fig. 2, illustrating the control of a simple hand-fired boiler, the corrugated steam diaphragm, called the load governor, is linked to one side of the jet pipe, as shown at *A*. Its action is opposed by a diaphragm *B* functioning on the pressure differential of the gases of combustion through the setting. When the steam pressure drops, the jet pipe moves to the left to open the flue damper *C* and increase the draft. With the increased quantity of gases the pressure in the combustion chamber tends to drop, but is restored by manipulation of damper *D* in the air supply by the




**Jet pipe control applied to hand-stoker-and pulverized-fuel fired boilers**

spring-opposed diaphragm *E*, for which the operating medium is the gas pressure in the upper part of the setting.

For a number of hand-fired or inclined-grate boilers the air quantity regulation in accordance with the steam pressure is much the same except that the load governor is common to all boilers and the oil from its jet pipe is used in the diaphragm of each flue damper regulator in lieu of steam.

Simultaneous regulation of a number of boilers fired by chain grates adds the control of the stoker motors. In the flue damper regulator air from a small fan on the stoker driveshaft is used instead of oil, thus tieing together the coal feed and the air supply. Fig. 3 diagrammatically shows the complete control system.

To obtain fine adjustment of stoker speed through a wide range, shunt-wound direct-current motors, preferably, are used. All drive motors are connected in parallel with the generator of a motor-generator set designed for voltage regulation on the Ward-Leonard principle.

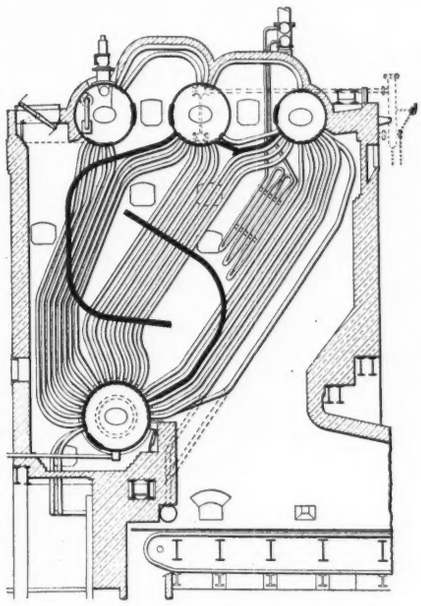
Automatic combustion control with pulverized-coal firing is illustrated in Fig. 4. The system is a variation of that used in stoker-fired plants. With increasing load it is necessary to increase the air much faster than the coal quantity, and vice versa with falling loads. To avoid an uneconomic air excess with frequent load changes, the speed of coal regulation is purposely kept low, while the flue damper is operated quickly. The main load governor influences only the coal quantity by control of the feeder motors, while the air quantity is governed indirectly by the revolutions of the screw feeders.

An innovation in this system is the direct use of the $CO_2$ recorder to correct air excess automatically. Fig. 4 shows a jet pipe linked directly to the pointer of the $CO_2$ recorder. The nozzle moves in accordance with the pointer and the oil pressure in the respective cylinder changes the balance in the standard flue damper regulator so that the power of the diaphragm at the right is lessened and that of the opposing diaphragm increased. The jet pipe in this regulator then changes its position to establish through the flue damper the new balance dictated by the $CO_2$ recorder. A valve in the oil line to the recorder jet opens at certain intervals to eliminate the time lag and establish stable working conditions in this part of the system.

## Boiler Cross-Baffles With Curved Corners

THE MOST RECENT DEVELOPMENT in cross-baffles for boilers of bent-tube design, that of building the baffles with curved corners instead of square corners as is usual practice, is shown in the accompanying illustration.

This improvement, according to the manufacturer, The Engineer Company, 17 Battery Place, New York City, in addition to reducing the draft loss through the boiler, prevents the formation of eddy currents, facilitates cleaning of the boiler by soot blowers, provides smoother passage for gas and eliminates dead gas pockets.



**Typical bent-tube boiler equipped with baffles having curved instead of square corners**

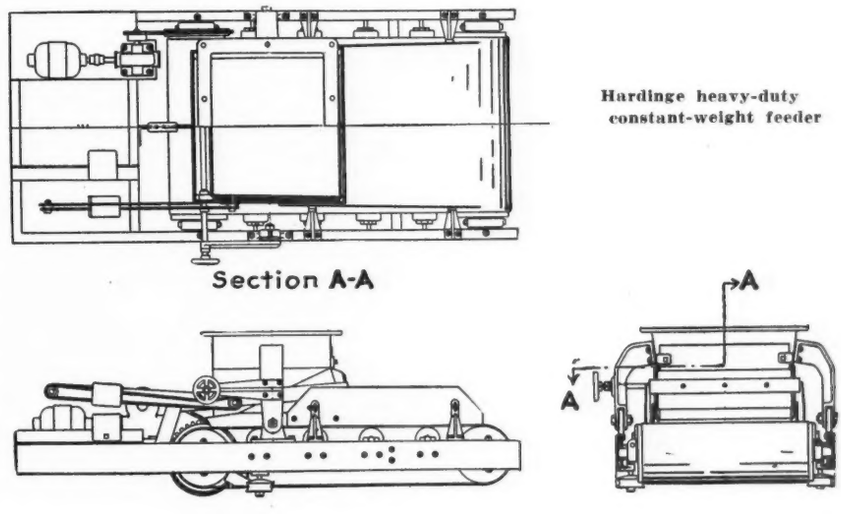
The most recent design provides a large opening for the first pass and places about 60 per cent of the heating surface in that pass. It also gives an increasing velocity as the gases cool, tending to maintain the rate of heat transfer in the second and third passes. The superheater arrangement is said to be particularly effective, as the same results are secured with the arrangement shown as with the between-deck location and tapered-gas pass design used on horizontal boilers.

The type of baffle shown is applicable to practically all sizes of standard bent-tube boilers using stokers, powdered coal, oil, hogged fuel or blast furnace gas.

## Constant-Weight Feeder

A NEW MODEL of the constant-weight feeder made by the Hardinge Company, York, Pa., originally described in the March 25, 1930, number of *Power*, has recently been announced. Known as Type D, it is a heavy-duty machine, built much stronger than the standard types previously available. It is supplied in capacities ranging from 10 to 1,000 tons per hour to handle material ranging from very fine powder to lumps as great as 5 in. in diameter.

In the original announcement the feeder was shown to consist of a conveyor, balanced like a scale beam, which weighed the load on the conveyor and adjusted a gate to control the flow of material from a feed hopper. The new model is identical in principle, although its construction is sturdier and it has been provided with additional idlers for supporting the conveyor belt. It may be equipped with a remote-control attachment which has been developed by the company, and with a no-load cutoff device which instantly stops the machine and signals the operator when the feed is interrupted.




**Hardinge heavy-duty constant-weight feeder**

# NEWS of the FIELD

## Smoke Prevention Association to Hold 25th Annual Convention on June 30 to July 3

### Setting heights, furnace requirements and fly-ash removal among topics for discussion at Grand Rapids

AT GRAND RAPIDS, MICH., from June 30 through July 3 the Smoke Prevention Association is to hold its 25th annual, "silver jubilee," convention. Hotel Pantlind will be headquarters. Three days will be devoted to the technical sessions of the meeting, and the fourth day to plant inspection and sightseeing. On June 30 the main themes will be smoke abatement in heating plants, and legislation. Smoke abatement in power plants and separation of solids from chimney gases are the subjects for discussion July 1. Railroad day is scheduled for July 2.

On July 1 plans are being made for a conference on standardizing setting heights and furnace requirements for fuel-burning equipment. Representatives from the following organizations have been invited to attend: American Boiler Manufacturers Association, Midwest Stoker Association, Fuels Division of the American Society of Mechanical Engineers, American Oil Burner Association, National Piping and Contractors Association, Cast Iron Boiler and Radiator Manufacturers, and the Steel Heating Boiler Institute.

Another question of importance slated for discussion at the convention is the removal of solids from chimney gases. Air pollution from this source is given on the average as 50 lb. of solids per ton of coal burned. The presence of experts in the field is anticipated and it is hoped that an agreement will be reached on definite standards for fly ash removal. Papers listed on the tentative program at this writing are: "Court Action vs. Education," James E. Carey; "Smoke Ordinance Enforcement," Gordon Rowe; "Legislation for Smoke Prevention," Senator Conlon of Grand Rapids; "Smoke Abatement with Warm Air Furnaces." V. W. Cherven; "Central Heating," A. W. Kastens; "Purposes and Activities of the Committee of Ten," Oliver J. Grimes; "Measurements of Smoke Densities and Soot Fall," W. A. Carter; "Boiler Practice," I. J. Van Kammen; "Heating with Gas Coke and Gas Firing," George D. Holliday.

"Five Years' Progress in Direct Steaming," L. G. Plant; "Smoke Abatement on Locomotives with Stoker Firing," J. H. Rewald; "Locomotive Stokers," F. P. Roesch; "Diesel Engine Locomotives," Eugene Kultchar; "Firing up and Roundhouse Practises," A. T. Mitchell; "Standard Setting Heights for Domestic Stokers," E. L. Beckwith; "Fly Ash Collection in the Detroit District," Charles J. McCabe; "Smoke as a Menace to Public Health," Dr. Edward Slemons.

## A.S.H.V.E. to Meet in Swampscott, June 22-25

THE SEMI-ANNUAL MEETING of the American Society of Heating and Ventilating Engineers will be held on June 22 to 25 in Swampscott, Mass., with headquarters at the New Ocean House. According to the program, committee meetings are scheduled for the afternoon of the first day, and technical sessions will be held in the morning on the three remaining days. Afternoons and evenings will be devoted to outdoor sports, sightseeing trips, dinners and dances.

Among the papers to be presented at the technical sessions, the following are of particular interest. "Flow of Steam Through Orifices Into Radiators," S. S. Sanford and C. B. Sprenger; "Friction Heads in One-Inch Standard Cast-Iron Tees," F. E. Giesecke and W. H. Badgett; "Using Gas Vapor Mixtures for Heating Purposes," C. A. Dunham; "Essential Elements for Determining Heating-Plant Requirements," F. B. Rowley; "Study of Performance Characteristics of Oil Burners and Low-Pressure Heating Boilers," L. E. Seeley and E. J. Tavanlar; "Heat and Moisture Losses From the Bodies of Men Working and Their Application to Air-Conditioning Problems," F. C. Houghton, W. W. Teague, W. E. Miller and W. P. Yant; "The Measurement of the Flow of Air Through Registers and Grilles," L. E. Davies.

Included on the program are the reports of committees on testing and rating unit ventilators, ventilation standards, research, rating and testing concealed gravity type radiation.

## New Rates in New York to Save $5,500,000 Yearly

A NEW SCHEDULE of rates for residence and power consumers of the four largest electric companies in New York City was ordered on May 2 by the state Public Service Commission. The commission directed the New York Edison Company, United Electric Light & Power Company, Brooklyn Edison Company and the New York & Queens Electric Light & Power Company to file new rate schedules immediately, which will reduce the net revenue of these companies by an amount estimated at $5,500,000.

Power consumers using more than 25 kw.-hr. per month and home consumers using more than 15 kw.-hr. per month will have their bills reduced, but those using less than these amounts (about 50 per cent of the consumers) will pay more, according to the schedules. Total reductions for power consumers are estimated at $2,100,000, and for residence consumers $2,400,000.

Summarized, the new rates are as follows: Residences—minimum charge $1 a month, which includes 10 kw.-hr.; 6c. for the next 5 kw.-hr., and 5c. for each additional kilowatt-hour. Commercial Enterprises—Demand charge $1 per meter per month per kilowatt of maximum demand where the demand exceeds 1 kw.; energy charge $1 per meter per month for the first 10 kw.-hr., 6c. per kilowatt-hour for the next 40, 5c. per kilowatt-hour for the next 4,950 and 4c. per kilowatt-hour for all over 5,000.

## Pinchot Urges Federal Control of All Utilities

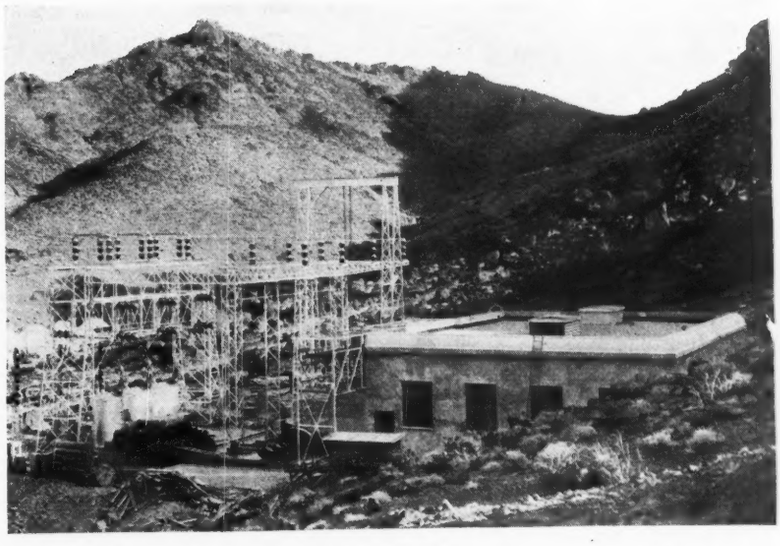
CHARGING that "the power of the public utilities is manifest in every political assembly from the Congress of the United States to the smallest town meeting" and predicting that unless this power is controlled, "we shall be the helpless servants of the most widespread, far-reaching and penetrating monopoly ever known," Governor Gifford Pinchot, of Pennsylvania, told the Governor's Conference in French Lick, Ind., on June 2, that effective utility regulation can only be secured by legislative action on the part of the Federal Government.

He pointed out the increase in the interstate transmission of electric power, over which the states have no jurisdic-

tion, and charged that four groups—the Morgan-Mellon, Harris - Forbes, North American and Insull interests—control 91 per cent of the central-station power throughout the country. "And these interests work together harmoniously under a common policy and toward a common end, which is the milking of the public," he declared, asserting that the "milking process" is already taking from the nation's consumers $500,000,000 annually in overcharges through "the device of the write-up."

Stating that the doctrine of state's rights had failed to meet the situation, he concluded, "I wish to express my firm conviction, based on no little practical experience, that the question of the public utilities cannot be settled by the individual states acting alone; that the effort to settle it by individual states acting alone is hopeless from the start; that the problem is essentially national in its character; and that it can be solved only under the leadership and by the action of the nation itself, assisted and supported, of course, by the co-ordinate action of the individual states."

## TO SUPPLY HOOVER DAM CONSTRUCTION



This substation of 15,000-kva. capacity, situated at the site of Hoover Dam, is the terminal of the 132-kva., 225-mile transmission line built by the Southern Sierras Power Company to connect with the company's system at San Bernardino. With the line nearly ready for testing out, power is expected to be delivered to the substation by the end of this month.

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## Fraud Charges Draw Promise Of Beauharnois Inquiry

CHARGES against the Beauharnois Light, Heat & Power Corporation, with public men and a member of the Quebec judiciary involved, resulted recently in the promise by Premier Bennett that a full Parliamentary inquiry will be held into all phases of the Beauharnois undertaking.

These charges emerged in the course of a debate in the Canadian House of Commons in which the whole Beauharnois development was held up as a gigantic scheme to secure to private interests the entire flow of the St. Lawrence River at the point where the company is proceeding with its big water-power project. Allegations of fraud, misrepresentation and improper dealing; charges that members of the Dominion Senate were interested in the power scheme, and intimations that the Beauharnois corporation had even gone so far as to attempt to corrupt members of the Quebec judiciary, featured a discussion which focussed the attention of the House.

Specifically, it was alleged that the company is proceeding illegally with a development for which it has never received the approval of the government. The construction which it has in progress differs, it was claimed, in important degree from the plans which the Order-in-Council of the late Liberal Government approved. The charges were raised by Progressive Leader Robert Gardiner, who urged that the undertaking, because of the features allegedly connected with it, should be taken over by the government and developed for the general good of the citizens of Canada.

While not entering into the discussion at any great length, Premier Bennett stated that the company had unquestionably exceeded its authority in the size of the canal it was constructing. He re-affirmed his position of a year ago, when he had held that there should be an inquiry and promised that there would be one now. It was suggested by Leslie Bell, Conservative member for St. Antoine, Quebec, that the attack upon the company was inspired by power interests opposed to it.

## Los Angeles Plans 100,500-Hp. Additions

PRELIMINARY PLANS for the addition of both steam and hydro-electric generating facilities to the Los Angeles, Calif., municipal power system are being made under the direction of H. A. Van Norman, general manager and chief engineer of the department of water and power. The city's board of water and power commissioners recently adopted resolutions ordering a study and report on the proposed additions, which would include an 80,000-hp. steam plant and the addition of 20,500 hp. of hydro capacity at power plant No. 2 in San Francisquito Canyon.

The city has no steam plant at present. The present capacity of power plant No. 2, which is one of a system of five hydro plants, is 41,800 hp. The tentative location of the proposed steam plant is at tidewater at Wilmington, in city territory. The plans under consideration contemplate the financing of the additions out of revenues, the purchase of materials and equipment to be made on the installment plan.

## Western Society Confers Honorary Memberships

AT ITS 62ND annual dinner meeting attended by 370 at the Sherman Hotel, Chicago, on May 28, the Western Society of Engineers conferred honorary memberships upon past-presidents W. L. Abbott, John Watson Alvord and C. F. Loweth, and upon Arthur H. Compton, professor of physics at the University of Chicago and the recipient of the Nobel Prize for Physics in 1927.

Guest speaker of the evening was the Hon. Anton J. Cermak, mayor of Chicago, who reviewed existing conditions in the city government and requested the cooperation of the society in attracting high-quality applicants for technical positions. He was followed by Charles Milton Newcomb, a well known humorist.

In reviewing the activities of the society for the past year President W. O. Kurtz referred to the unqualified success of the seven scientific meetings that had been proposed and sponsored by Past-President W. S. Monroe. In civic work the joint representations of the architects and engineers to the Board of Education had been outstanding. Mention also was made of committee work on a plan of employment insurance.

Newly elected officers for the coming year were introduced as follows: Frank D. Chase, president; D. J. Brumley, first vice-president; H. B. Gear, second vice-president; C. C. Whittier, third vice-president; L. S. Keith, treasurer; L. D. Gayton, incoming trustee for three years.

## R. B. McWhorter Named Chief Engineer, Power Commission

ROGER B. MCWHORTER, of Alabama, has been chosen by the Federal Power Commission as its chief engineer. He will be the first civilian engineer to conduct the commission's engineering work. Under the Water Power Act as originally passed this service was to be performed by officers of the Corps of Engineers. The amendment to the act last year terminated that provision but allows the commission to continue to use engineers from the War, Interior and Agricultural Departments on work outside of Washington.

Mr. McWhorter was chosen for his ability as an engineer and because of his great familiarity with the St. Lawrence and the Tennessee River projects, it is stated. He was born at Riverton, Ala., in 1888, and graduated from the Alabama Polytechnic Institute with a degree in civil engineering. During the construction of Muscle Shoals he served as an engineer on the project, and later was in charge of estimating costs on the proposed St. Lawrence River power development for the joint board of United States and Canadian engineers. Last year he was one of the chief advisors to the engineering board appointed by Governor Roosevelt of New York to report on the St. Lawrence project. Since last September he has been chief engineer of the Great Lakes division of the Corps of Engineers.

In his new position, Mr. McWhorter has as his principal assistant Franklin D. Nash, Louisiana engineer, who is now engaged in an examination of the power situation at Niagara Falls.

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## Obituary

HERBERT E. STONE, former president of the National Association of Stationary Engineers, died on May 30 at his home in Framingham, Mass. He was born in Bethel, Me., 69 years ago. In his work as a power engineer, he supervised the installation of the plants at Harvard University and Wellesley College. He was a member of many fraternal organizations and served at one time as president of the Massachusetts Federation of Square and Compass Clubs.

ARTHUR M. HUDDEL, president of the International Union of Operating Engineers, died at Sibley Hospital in Washington, D. C., on June 1. Death was directly due to pneumonia which developed following a cerebral hemorrhage on May 26, but a recent attack by an unknown gunman, believed to have been inspired by the alleged embezzlement of $36,000 from the union's benefit fund, was given as a contributing cause. He was 62 years old.

JOHN T. ARNOLD, former general manager and superintendent of the Westinghouse Electric & Manufacturing Company's plant at Attica, N. Y., died on May 31. Mr. Arnold went to Attica from Chicago 26 years ago to establish the company's plant there. He retired last year.

WALTER ALFRED MOSER, for more than ten years manager of the Salt Lake City (Utah) office of the Westinghouse Electric & Manufacturing Company, died, at the age of 45, in that city May 22 after an illness of about seven weeks. He had been affiliated with the Westinghouse company since June, 1907. A native of Union Hill, N. J., Mr. Moser spent most of his youth in Lincoln, Neb., and was graduated from the School of Engineering of the University of Nebraska.

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## COMING CONVENTIONS

**American Society of Mechanical Engineers.** National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 23-26. Secretary, Calvin Rice, 33 West 39th St., New York City.

**American Institute of Electrical Engineer.** Annual summer convention in Asheville, N. C., June 22-26. District meeting at Lake Tahoe, Calif., Aug. 25-28. Secretary, F. L. Hutchinson, 33 West 39th St. New York.

**American Society of Heating and Ventilating Engineers.** Semi-annual meeting at the New Ocean House, Swampscott, Mass., June 22-26. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

**American Society for Testing Materials.** Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

**Association of Iron and Steel Electrical Engineers.** Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

**International Railway Fuel Association.** Annual convention at the Hotel Sherman, Chicago, Ill., Sept. 15-16. Secretary, C. T. Winkless, Room 700, La Salle Street Station, Chicago, Ill.

**National Association of Power Engineers.** Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

**Smoke Prevention Association.** Annual meeting at the Hotel Pantlind, Grand Rapids, Mich., June 30-July 3. Secretary, Frank A. Chambers, City Hall, Chicago, Ill.

**Third International Conference on Bituminous Coal.** At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

**Universal Craftsmen Council of Engineers.** Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

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## Personals

J. D. Ross, former superintendent of the municipal lighting department of Seattle, Wash., is now in New York City, acting as an advisor to the New York Power Authority appointed recently by Governor Roosevelt to formulate plans for the development of the power resources in the International Rapids section of the St. Lawrence River.

PHILLIP M. WENTWORTH, for many years associated with the Stone & Webster organization in the management and supervision of electric, gas and transportation properties, has recently been elected a vice-president of the Stone & Webster Service Corporation. He will make his headquarters in Boston, Mass.

J. C. MCQUISTON, for the past 29 years general advertising manager of the Westinghouse Electric & Manufacturing Company and one of the best-known advertising executives in the country, retired from business on June 1. Mr. McQuiston entered the advertising profession when it was in its infancy, and has contributed greatly to its growth and organization. He now plans to start on an extended cruise around the world.

T. B. WILSON, vice-president and general manager of the Louisville Gas & Electric Company since 1924, was recently elected president of the company to succeed JOHN J. O'BRIEN, who as president of Byllesby Engineering & Management Corporation and the Standard Gas & Electric Company, has served also as president of most of the affiliated companies.

H. S. CLOAK, engineer, has been appointed chairman of the reorganized board of public utilities of the City of Alameda, Calif., by the newly elected mayor, W. H. HENNING, an engineer affiliated with Thebe, Starr & Anderton, who is serving the city without salary in the interest of an efficient administration of the light department. The other members of the board are HOWARD BAXTER and NEIL B. PIERSON, city manager.

DR. KARL T. COMPTON, president of the Massachusetts Institute of Technology, has been made the 36th recipient of the Rumford Medal, which the American Academy of Arts and Sciences awards for the most important discoveries, or useful improvements, in light and heat in North America.

THOMAS A. EDISON was honored last month in Germany with the unveiling of a marble bust in the Hall of Honor of the Deutsches Museum, Munich. The Edison bust, sponsored by the American Institute of Electrical Engineers and the Edison Pioneers, is one of two accorded a position in the museum hall. The other is that of von Siemens, noted German scientist and engineer.

# Business Notes

ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, Wis., is negotiating with the AMERICAN BROWN BOVERI COMPANY, Camden, N. J., for the purchase of the latter's electrical manufacturing business, according to press reports. The principal products to be acquired by Allis-Chalmers are mercury arc rectifiers, electric furnaces, switchgear, traction equipment, blowers and compressors, it is stated.

JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, announces that Neil E. Salsich was elected vice-president and general sales manager at a recent meeting of the board of directors. Mr. Salsich was formerly associated with the BETHLEHEM STEEL CORPORATION as manager of railroad and mining sales.

HOFFMAN COMBUSTION ENGINEERING COMPANY, Detroit, Mich., has contracted with the FAIRMONT MINING MACHINERY COMPANY, Fairmont, W. Va., to manufacture and sell "Firite" stokers on a royalty basis, in the territory east and south of the Ohio River and west of the Mississippi River. The Fairmont company is a subsidiary of the CONSOLIDATION COAL COMPANY.

THE BUDA COMPANY, Harvey, Ill., is celebrating its 50th anniversary this year. It was established at Buda, Ill., in 1881 to manufacture railroad supplies, and ten years later moved to Harvey, where it has grown to its present size.

CHICAGO PNEUMATIC TOOL COMPANY, New York City, announces the election as executive vice-president of W. L. Lewis, who for the past year has been vice-president in charge of finance for the company, and was formerly assistant comptroller of the BETHLEHEM STEEL CORPORATION.

COKAL PULVERZONE CORPORATION is the new corporate name of the COKAL STOKER CORPORATION, Chicago, Ill., according to an announcement made recently by the company. The change was made because it is considered that the term "Pulverzone" is more inclusively descriptive of the company's products than "Stoker."

DIAMOND ELECTRICAL MANUFACTURING COMPANY, Los Angeles, Calif., which is affiliated with the SQUARE D COMPANY, Detroit, Mich., recently opened a new branch factory at 130 Potrero Ave., San Francisco, Calif. J. J. Mitchell, former branch sales manager of the Square D Cleveland office, is sales manager of the new branch.

GENERAL REFRACTORIES COMPANY, Philadelphia, Pa., announces that at a recent board of directors' meeting Burrows Sloan was elected chairman of the board; John R. Sproul was elected president; E. A. McKelvy, vice-president, and Roger A. Hitchins, secretary and treasurer.

## How's Business?

THE CURRENT trade statistics are of no special significance save as showing sustained resistance to further radical recession and an early onset of the usual summer slackness. Our index has shaded off slightly during May, and is back to the level of the beginning of the year. Commodity price declines continue, and wheat has settled sharply to expected open market levels as Farm Board support is withdrawn and the new crop starts to move. But neither commodity nor security quotations now reflect economic actualities, and rational revaluation is inevitable. Those who recognize this early will not regret it.—*The Business Week,* June 10.

# Trade Catalogs

PUMPS AND TURBINES—A new catalog, No. B-1, has just been issued by the De Laval Steam Turbine Company, Trenton, N. J., describing and illustrating "clogless" pumps for handling liquids that carry solids in suspension. Another new publication of the company, Leaflet E-1146, presents comprehensive information on the pump installation at Ross station in Pittsburgh. A third illustrated bulletin contains full information on the high-pressure steam turbine installation in the new tanker "G. Harrison Smith," which is said to have greatly bettered the fuel consumption of 0.63 lb. of oil per shaft horsepower.

FEED-WATER TREATMENT — "Boiler Water Conditioning" is the title of the new illustrated treatise just published by the Elgin Softener Corporation, Elgin, Ill., which discusses various phases of feed-water treatment, including types of sludge and scale, corrosion and pitting, embrittlement and methods of chemical control.

VENTILATORS AND HUMIDIFIERS — Catalog No. 337, recently issued by the B. F. Sturtevant Company, Hyde Park, Boston, Mass., illustrates and describes in detail the company's new unit ventilator for schools and public buildings. Other new publications of the company include Catalog No. 383 on a new humidifier applicable to practically all types of industries, Bulletin No. 384 covering suspended-type air-conditioning units for industrial use, and Bulletin No. 385 describing a new propeller fan.

SPRAY NOZZLES—Monarch Manufacturing Works, Inc., Salmon and Westmoreland Sts., Philadelphia, Pa., has just issued a new catalog, No. 6-C, which describes and illustrates a complete line of spray nozzles for industrial and power-plant applications. The catalog also contains information on pressure-regulating and cut-off valves.

STEAM TRAP—A new compound steam trap of high capacity is described in an illustrated folder recently issued by the Armstrong Machine Works, 820 Maple St., Three Rivers, Mich.

INDICATING THERMOMETERS — The Foxboro Company, Foxboro, Mass., has recently issued a 32-page bulletin, No. 148-2, on dial-type indicating thermometers. Besides illustrated descriptions of each style of thermometer, it contains information on dials, ranges, bulbs, tubing, gageboards and other details.

▼

# Fuel Prices

## FUEL OIL

**Boston**—June 2, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.91c. per gal.; 28@32 deg., 4.85c. per gal.

**New York**—June 4, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

**Philadelphia**—May 26, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

**Pittsburgh**—May 27, f.o.b. local refinery, fuel oil, 30@34 deg., 2.625c.@2.875c. per gal.; 36@40 deg., 2.625c.@2.875c. per gal.

**Cincinnati**—June 2, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

**Chicago**—June 1, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 36.25c. per bbl.; 22@24 deg., 40c. per bbl.; 24@26 deg., 45c. per bbl.; 26@28 deg., 52.5c. per bbl.; 28@30 deg., 62.5c. per bbl.

**St. Louis**—May 27, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.17 per bbl., or 42 gal.; 26@28 deg., $1.27 per bbl.; 28@30 deg., $1.345 per bbl.; 30@32 deg., $1.445 per bbl.; 32@36 deg., gas oil, 2.651c. per gal.; 38@40 deg., distillate, 3.526c. per gal.

**Dallas**—May 30, f.o.b. local refinery 24@26 deg., 95c. per bbl. or 42 gallons.

## COAL

| Bituminous (Net Tons) | At Mine, for Shipment to | Price per Ton |
|---|---|---|
| Pool 9, super low-vol. | New York... | $1.70 @$1.90 |
| Pool 10, h. gr. low-vol. | New York... | 1.60 @ 1.70 |
| Pool 11, low-vol. | New York... | 1.40 @ 1.50 |
| Smokeless, mine-run | Chicago..... | 1.50 @ 1.75 |
| Smokeless, slack | Chicago..... | .60 @ 1.25 |
| Harlan, Ky., slack | Chicago..... | 1.10 @ 1.20 |
| Franklin, Ill., mine-run | Chicago..... | 2.15 |
| Franklin, Ill., screen | Chicago..... | 1.50 @ 1.75 |
| Ind. 5th Vein, m.-r. | Chicago..... | 1.20 @ 1.75 |
| Standard Ill., mine-run | St. Louis.... | 1.25 @ 1.40 |
| W. Ky., mine-run | Louisville.... | .85 @ 1.25 |
| W. Ky., slack | Louisville.... | .70 @ .80 |
| Pittsburgh, mine-run | Pittsburgh.... | 1.35 @ 1.45 |
| Smokeless, mine-run | Cincinnati... | 1.65 @ 1.75 |
| Smokeless, slack | Cincinnati... | 1.00 @ 1.25 |
| Kanawha, mine-run | Cincinnati... | 1.10 @ 1.35 |
| Kanawha, nut-slack | Cincinnati... | .75 @ 1.15 |
| **Anthracite (Net Tons)** | **At Mine, for Shipment to** | **Price per Ton** |
| Buckwheat | New York... | $3.25 @$4.00 |
| Barley | New York... | 1.00 @ 1.40 |

# New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

**Calif., Belmont** — Belmont Water District, plans to vote $85,000 bonds for purchase of privately owned water system and construction of reservoir and pumping plant. G. A. Kneese, Stafford Bldg., Redwood City, is engineer.

**Calif., Brawley**—City defeated $150,000 bond election for construction of a municipal power plant. Burns-McDonell-Smith Engineering Co., Western Pacific Bldg., Los Angeles, Engr.

**Calif., Los Angeles**—M. J. Connell, Connell Bldg., plans the construction of a 13 story office, loft and stores building at 7th and Los Angeles Sts. Estimated cost $1,750,000. J. T. Payne, 321 West 23rd St., is architect.

**Conn., Bristol**—Connecticut Light & Power Co., W. W. Foreman, Engr. in Charge, 111 West Main St., will build a steam regenerating plant on Leavenworth St. Estimated cost $175,000. Work will be done by day labor. Contract for steel and outside awarded.

**Conn., Newtown** — Fairfield State Hospital Commission, N. G. Osborn, Old Senate Chamber State House, Hartford, will receive bids until June 30 for the construction of a group of buildings including nurses' home, hospital, etc., on Mile Hill. Estimated cost $1,250,000. W. P. Crabtree, 410 Asylum St., Hartford, is architect.

**D. C., Anacostia**—Bureau of Yards & Docks, Navy Dept., Washington, will receive bids until June 17 for barracks and boiler plant at Naval Air Station here.

**Ind., Evansville**—City will receive bids about June 15 for the construction of a central fire alarm station including radio broadcasting station, battery rooms, apparatus rooms and boiler rooms at Seventh and Walnut Sts. Estimated cost $30,000.

**Ind., Newcastle** — Village of Epileptics, awarded contract for the construction of a power plant at State Hospital, to A. R. Hunnicut, Newcastle. Estimated cost $40,000. Mechanical equipment will be installed.

**Ia., Cedar Falls**—State Bd. of Education, W. H. Gemmill, Secy., Capitol Bldg., Des Moines, will receive bids until June 15 for the construction of a heating and power plant, shops, and garage for Iowa State Teachers College. Estimated cost $365,000. E. E. Cole, Dept. Bldg. Const., Iowa State Teachers College, is architect. B. P. Fleming, Las Cruces, N. M., is engineer.

**Ia., Sioux City**—Swift & Co., is receiving bids for the construction of a 2 story, 62 x 102 ft. addition to cooling plant on Leech St. Estimated cost $85,000. Private plans.

**Kan., Dodge City**—Kansas Power Co., c/o H. S. Kilby, Gen. Mgr., Operating Dept., Salina, will receive bids about June 15 for the construction of a 2 story, 50 x 125 ft. power plant, including feed water heaters, air heaters, etc., on Fort Dodge Rd. here. Sargent & Lundry, Inc., 20 North Wacker Dr., Chicago, Ill., are engineers. Contracts let for 104 ft. smoke stack, 6,000 kw. turbine, two 6,000 sq.ft. boilers and superheaters.

**Ky., Louisville**—Roseland Holding Corp., c/o Joseph & Joseph, Breslin Bldg., Archts., awarded contract for the construction of a 14 story apartment building at 1249 South Third St. to D. C. Kay, 18 Strathearn Bldg., Toronto, Ont. Estimated cost $1,000,000.

**La., Natchitoches**—City voted $55,000 bonds for the construction of a waterworks and electric light plant.

**Mass., Boston**—Commonwealth of Mass., Dept. of Public Works, is having preliminary plans prepared for the construction of an 8 story office building on Nashua St. Estimated cost $1,000,000. Adden, Parker, Clinch & Crimp, 177 State St., Boston, are architects.

**Mass., East Springfield**—United Electric Light Co., 73 State St., Springfield, will build a substation on Page Blvd. Estimated cost to exceed $40,000. Private plans. Work will be done by separate contracts. Contract for foundation let.

**Mass., Greenfield**—Greenfield Ice & Trucking Co., R. C. Phelps, 56 Union St., awarded contract for the construction of an artificial ice plant on Bernardston Rd., to T. J. Gass Co., 124 High St. Estimated cost $40,000.

**Mass., Reading**—City awarded contract for the construction of a 25 x 30 ft. pumping station to A. B. Rounds, 58 Montvale Ave., Stoneham, also wells and well connections to S. B. Hamilton, 43 Beech St., Melrose. Estimated total cost $50,000.

**Miss., Waynesboro** — City is having preliminary plans prepared for the construction of a municipal light and power plant. Estimated cost $69,500.

**Mo., St. Louis**—Southwestern Bell Telephone Co., 11th and Pine Sts., awarded contract for the construction of a telephone exchange building at Delmar and Clarendon Ave., to J. H. Bright Contracting & Building Co., Arcade Bldg., St. Louis. Estimated cost $1,860,000.

**N. J., Atlantic City**—Hotel Traymore, plans the construction of a 30 story addition to hotel at Indiana St. and Boardwalk. Estimated cost $6,250,000. R. B. Bencker, 1601 Chestnut St., Philadelphia, Pa., is architect.

**N. J., Browns Mills**—Deborah Jewish Relief Society, M. M. Unger, 763 Broad St., postponed construction of a sanitorium including steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc., here. Estimated cost $600,000. F. Grad, 1023 Broad St., Newark, Archt. Indefinite when project will mature.

**N. J., Elizabeth** — Elizabethtown Consolidated Gas Co., 16 West Jersey St., plans the construction of a power plant and boiler room at Third Ave. and Erie St. Estimated cost $40,000. Private plans.

**N. Y., New York**—Continental Realty Corp., F. M. Hornby, Pres., 25 Broad St., is having preliminary plans prepared for the construction of a 48 story office building at 30 to 40 Broad St. Estimated cost $4,500,000. Morris & O'Connor, 101 Park Ave., are architects. Thompson Starrett Co., 250 Park Ave., will receive bids in July for excavation, steel and various other sub-contracts.

**Pa., Pittsburgh** — East Liberty Presbyterian Church, C. A. Fisher, Chn. of Bldg. Commission, 503 Highland Ave., plans the construction of a church, parish house and rectory at Penn Ave., South Highland and South Whitfield Sts. and Baum Blvd. Estimated cost $3,000,000. Cram & Ferguson, 248 Boylston St., Boston, Mass., are architects. James L. Stuart, 518 Oliver Bldg., is supervising engineer.

**Tex., Caldwell**—City awarded contract for the construction of a municipal power plant including power house, double unit with two oil burning engines and two generators to Fairbanks, Morse & Co., Dallas. Estimated cost $40,000.

**Tex., Fort Sam Houston**—Constructing Quartermaster, War Dept., will receive bids until June 16 for construction and completion of two air corps hangars, including compressor room, etc., at Duncan Field.

**Tex., Wellington** — City plans an election June 23 to vote $80,000 bonds for the construction of a municipal natural gas system including booster plant, etc. Private plans.

**Va., Langley Field** — Constructing Quartermaster, will receive bids until June 15 for the construction of eleven air corps hangars, boiler house, etc., at Langley Field. Estimated cost $1,750,000.

**Wash., Seattle**—One Thousand One Hundred Seven Seneca St. Corp., plans the construction of a 20 story apartment building and hotel at 7th and Bell Sts. Estimated cost $1,000,000. T. C. Haire, c/o owner, is architect.

**Ont., Toronto**—Maple Leaf Garden Hockey Club, 13 King St. W., awarded contract for the construction of a hockey and sports arena, including air cooling and ventilation systems to Thomson Bros., 56 Grenville St. $989,297.

## Equipment Wanted

**Alternators, Switchgear and Transformers — Cairo, Egypt**—Dept. of Interior, will receive bids until July 11 for Diesel driven alternators, switchgear, transformers and pumping sets, also 40 ton crane for electric power station at Mansourel.

**Boiler—Gonzales, Tex.**—Treasury Dept., Office of the Supervising Archt., Washington, D. C., will receive bids until June 18 for new heating boiler, etc., at U. S. Post Office here.

**Condenser—Pasadena, Calif.**—City will receive new bids for steam condenser for municipal light plant. Former bids rejected.

**Engine—Holly Springs, Miss.**—City plans to purchase a 280 hp. oil burning engine.

**Generating Unit—Litchfield, Minn.**—City, M. Mortenson, Recorder, will receive bids until June 15 for furnishing and installing a 750 kw. steam turbine generating unit. Estimated cost $55,000.

**Generators—St. Louis, Mo.**—Bd. of Public Service, 208 City Hall, will receive bids until June 30 for furnishing and erecting one 400 kw. d.c. and one 200 kw. a.c. direct connected steam engine driven generators at Sanitarium power house of St. Louis waterworks.

**Motors—New Orleans, La.**—Sewerage & Water Board, will receive bids until July 15 for two 450 and two 250 hp. vertical synchronous motors.

**Pumping Equipment—Walpole, Mass.**—City plans to purchase pumping equipment in connection with proposed sewage system. Estimated cost $140,000.

**Transformers—Cleveland, O.**—City will receive bids until June 12 for distribution transformers.

## Industrial Projects

**Conn., Waterbury**—Lux Clock Mfg. Co., 97 Sperry St., is having plans prepared for addition to electric clock manufacturing plant. Estimated cost to exceed $40,000. T. Freney, 51 Leavenworth St., is architect.

**Mass., New Bedford**—Continental Wood Screw Co., 459 Mount Pleasant St., plans a 2 story, 50 x 100 ft. addition to factory. Estimated cost $45,000. F. A. Walker, Mt. Pleasant St., is architect.

**Mass., Taunton** — Taunton Pearl Works, 35 Vernon St., is receiving bids for the construction of a 2 story factory on Ingell St. Estimated cost $40,000. Jackson & Moreland, 31 St. James Ave., Boston, are architects.

**N. Y., Bolivar**—Allegany Refineries, Inc., c/o W. E. Sawyer, plans the construction of an oil refinery, 500 bbl. capacity. Estimated cost to exceed $200,000.

**N. J., East Rutherford** — J. T. Camlet, 26 Piaget Ave., Clifton, Archt., will receive bids about July 15 (extended date) for the construction of a 2 story, 38 x 70 ft. factory on Mozart St., for East Rutherford Syringe Co., 75 Mozart St. Estimated cost $40,000.

**O., Cleveland** — Addressograph-Multigraph Corp., J. E. Rodgers, Pres., E-409 Perkins Ave., awarded contract for the construction of a 1 story, 580 x 620 ft. factory, 148 x 160 ft. office building and 64 x 68 ft. boiler house on Babbitt Rd. to H. K. Ferguson Co., Hanna Bldg. Estimated cost $1,000,000. Contracts not yet let for one battery of two 325 hp. tube boilers, two feed water regulators, two boiler feed pumps, governors, ash and coal conveyor.

**Tex., Hawley**—E. W. Mountray, Abilene, ready to build 1,000 bbl. oil refinery near Abilene. Estimated cost $80,000. Private plans. Taking proposals on machinery and equipment.

**Tex., Nacogdoches** — J. A. Killian, North Church St., awarded contract for the construction of a 1 story, 40 x 100 ft. tomato canning plant including boiler room, loading racks, etc. Estimated cost $60,000. Private plans. Equipment will be required.

**Wis., Milwaukee**—Chain Belt Co., 736 Park St., awarded contract for a 1 story, 90 x 106 ft. addition to factory on West Bruce St., to Klug & Smith, 111 East Wisconsin St.

**Wis., Racine**—Modine Mfg. Co., manufacturers of gas engine radiators, awarded contract for the construction of a 4 story, 80 x 111 ft. addition to factory to W. M. Christensen Construction Co., Racine.

**N. B., Woodstock**—Haydens Ltd., plans the construction of a sawmill and woodworking plant. Estimated cost $100,000. Equipment will be required.

**Ont., York** — Patons & Baldwin Ltd., 888 Dupont St., Toronto, awarded contract for the construction of a woolen mill, including 68 x 80 ft. power house and 80 x 180 ft. dye house, to Wilde & Brydo, Canadian Pacific R.R. Bldg., Toronto.

**Que., Montreal**—Rockbestos Products Corp., 285 Nicoll St., New Haven, Conn., plans the construction of a plant for the manufacture of electric equipment here.

# PRICES - MATERIALS - SUPPLIES

**Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.**

## SINCE LAST MONTH

MOMENTUM gained in the downward course of prices during April, carried over into May further declines in cement, oils, babbitt metal, armored cable and rubber-covered copper wire. In addition, lower prices went into effect during the month on wiping materials. There were no advances in the various materials and supplies listed here. Demand for industrial equipment and other electrical goods is at lowest levels touched in the last seven years. No. 14, solid, BX cable remained unchanged but No. 12 dropped $4.02 per M ft., to $34, during May. No. 14, r.-c., copper wire is off 10c. per M ft., to $4.40, f.o.b., N. Y., for solid, single-braid.

## POWER-PLANT SUPPLIES

**HOSE**—Quotations at New York warehouses:

| | Fire Protection | 50-Ft. Lengths |
|---|---|---|
| Underwriters' 2½-in., coupled, single jacket, net, per ft. | | $0.51 |
| Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less | | 70% |

Air—Best Grade, Net

| | | | | |
|---|---|---|---|---|
| ¼-in., per ft. | 3-ply | $0.271 | 4 ply | $0.337 |

Steam—Discounts from List

| | | | | | | |
|---|---|---|---|---|---|---|
| First grade | 59% | Second grade | 60-5% | Third grade | 60-10-10% | |

**RUBBER BELTING**—List price, 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting:

| | | | |
|---|---|---|---|
| Best grade | 60-10-10% | Second grade | 70-10% |

**LEATHER BELTING**—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

| Grade | Discount from list |
|---|---|
| Medium | 30-10% |
| Heavy | 30% |

**RAWHIDE LACING**—Cut lacing, best quality, 30-10%; 2nd quality, 50%. Lace leather sides, best, 12-17 sq.ft., 55c. per sq.ft.; 2nd, 48c., net. Giant or Indian tanned cut lacing, 30-10%.

**PACKING**—Prices per pound at New York warehouses:

| | |
|---|---|
| Rubber and duck for low-pressure steam, ⅛ in. | $0.90 |
| Asbestos for high-pressure steam, ⅛ in. | 1.75 |
| Duck and rubber for piston packing | .90 |
| Flax, regular | 1.15 |
| Flax, waterproofed | 1.70 |
| Compressed asbestos sheet | .85 |
| Wire insertion asbestos sheet | 1.20 |
| Rubber sheet | .45 |
| Rubber sheet, wire insertion | .75 |
| Rubber sheet, duck insertion | .55 |
| Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes | 1.40 |
| Asbestos wick, ½- and 1-lb. balls | .50 |

**PIPE AND BOILER COVERING**—Discounts from list at New York warehouses are as follows:

| | | |
|---|---|---|
| 85% magnesia, high pressure | | 40 % |
| Asbestos, air cell, for low-pressure heating and return lines | 4-ply | 65 % |
| | 3-ply | 67½% |
| | 2-ply | 70 % |

**PORTLAND CEMENT**—New York, $1.85@$2.00 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl. in cloth.

**STRUCTURAL STEEL**—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $2.90 per 100 lb. in lots of 1,000 to 3,999 lb.

**COTTON WASTE**—The following prices are in cents per lb., at warehouse:

| | New York | Cleveland | Chicago |
|---|---|---|---|
| White | 7.00@11.00 | 13.00 | 13.00 |
| Colored | 5.50@9.00 | 9.00 | 9.00 |

**WIPING CLOTHS**—Prices per pound in lots of about six bales (600 lb.), for colored wipers, as follows:

| | |
|---|---|
| New York | $0.10 |
| Cleveland | .08 |
| Chicago | .09 |

**LINSEED OIL**—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

| | New York | Minneapolis | Chicago |
|---|---|---|---|
| Per pound | $0.092 | $0.103 | $0.10 |

**WHITE AND RED LEAD**—Per 100-lb. keg, base price, f.o.b., New York:

| | Dry | In Oil |
|---|---|---|
| Red | $13.25 | $14.75 |
| White | 13.25 | 13.25 |

**RIVETS**—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list less 65% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, full kegs, per 100 lb.:

| | |
|---|---|
| New York | $4.00 |
| Chicago | 4.00 |
| Pittsburgh mill | 2.75 |

Broken kegs, about 50c. higher.

**REFRACTORIES**—Prices in car-loads, f.o.b. plant:

| | | |
|---|---|---|
| Chrome brick, eastern shipping points | per net ton | $45.00 |
| Chrome ore, ground, 40@50%, $Cr_2O_3$, in bulk | per net ton | 22@25 |
| Chrome ore, ground, 40@50%, $Cr_2O_3$, in sacks | per net ton | 26@29 |
| Chrome ore, crude, 40@50%, $Cr_2O_3$ | per net ton | 18.00@22.50 |
| Magnesite brick, 9-in. straights | per net ton | 65.00 |
| Magnesite brick, 9-in. arches, wedges and keys | per net ton | 71.50 |
| Magnesite brick, soaps and splits | per net ton | 91.00 |
| Silica brick, Mt. Union, Pa. | per M | 43.00 |
| Clay brick, 1st quality, 9-in. shapes, Pennsylvania | per M | 40@43 |
| Clay brick, 1st quality, 9 in. shapes, Ohio | per M | 40@43 |
| Clay brick, 1st quality, 9 in. shapes, Kentucky | per M | 40@43 |
| Clay brick, 1st quality, 9 in. shapes, Maryland | per M | 40@43 |
| Clay brick, 2nd quality, 9 in. shapes, Pennsylvania | per M | 35@38 |
| Clay brick, 2nd quality, 9 in. shapes, Ohio | per M | 32@35 |
| Clay brick, 2nd quality, 9 in. shapes, Kentucky | per M | 32@35 |
| Clay brick, 2nd quality, 9 in. shapes, Maryland | per M | 32@35 |

**BABBITT METAL**—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

| | |
|---|---|
| Genuine, highest grade | 41.50 |
| Commercial genuine, intermediate grade | 32.75 |
| Anti-friction metal, general service | 28.00 |
| No. 4 babbitt, f. o. b. | 9.00 |

**COLD-FINISHED STEEL**—Warehouse prices on shafting and screw stock, per 100 lb., base, are as follows:

| | New York | Cleveland | Chicago |
|---|---|---|---|
| Round or hexagon | $3.40 | $3.40 | $3.35 |
| Flat or square | 3.90 | 3.90 | 3.85 |

**BOILER FITTINGS**—Discounts from list at New York warehouse:

| | |
|---|---|
| Copper ferrules | 70% |
| Flanges | 50% |
| Stay bolts | 60% |
| Patch bolts | 20% |
| Fitting-up bolts | 45% |
| Pressed steel boiler lugs | 10% |

**WROUGHT PIPE**—The following basing discounts from list, are for large mill lots at Pittsburgh mill:

BUTT WELD

| | Steel | | | Iron | |
|---|---|---|---|---|---|
| Inches | Black | Galv. | Inches | Black | Galv. |
| 1 to 3 | 64% | 52½% | 1 and 1¼ | 31% | 15% |

LAP WELD

| | | | | | |
|---|---|---|---|---|---|
| 2 | 57% | 45½% | 2 | 23% | 9% |
| 2½ to 6 | 61% | 49½% | 2½ to 3½ | 28% | 13% |
| 7 and 8 | 58% | 45½% | 4 to 6 | 30% | 17% |
| 9 and 10 | 56% | 43½% | 7 and 8 | 29% | 16% |
| 11 and 12 | 55% | 42½% | 9 to 12 | 26% | 11% |

BUTT WELD, EXTRA STRONG, PLAIN ENDS

| | | | | | |
|---|---|---|---|---|---|
| 1 to 1½ | 62% | 51½% | 1 to 2 | 34% | 18% |
| 2 to 3 | 63% | 52½% | | | |

LAP WELD, EXTRA STRONG, PLAIN ENDS

| | | | | | |
|---|---|---|---|---|---|
| 2 | 55% | 44½% | 2 | 29% | 13% |
| 2½ to 4 | 59% | 48½% | 2½ to 4 | 34% | 20% |
| 4½ to 6 | 58% | 47½% | 4½ to 6 | 33% | 19% |
| 7 and 8 | 54% | 41½% | 7 and 8 | 31% | 17% |
| 9 and 10 | 47% | 34½% | 9 to 12 | 21% | 8% |
| 11 and 12 | 46% | 33½% | | | |

**BOILER TUBES**—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

| Size, Inches* | B.W.G. | Toncan Seamless Iron | Knobbled Charcoal Iron | Seamless Steel | Lapwelded Steel |
|---|---|---|---|---|---|
| 1 | 13 | $34.00 | ..... | $18.00 | ..... |
| 1¼ | 13 | 37.75 | ..... | 20.25 | ..... |
| 1½ | 13 | 38.00 | $38.00 | 19.25 | ..... |
| 1¾ | 13 | 30.00 | 30.00 | 22.00 | ..... |
| 2 | 13 | 26.25 | 26.25 | 20.25 | $19.00 |
| 2¼ | 13 | 34.50 | 34.50 | 23.00 | 25.00 |
| 2½ | 12 | 34.00 | 34.00 | 26.00 | 24.25 |
| 2¾ | 12 | 40.50 | 40.50 | 28.50 | 27.50 |
| 3 | 12 | 42.50 | 42.50 | 27.00 | 25.50 |
| 3¼ | 11 | 50.25 | 50.25 | 30.75 | 28.75 |
| 3½ | 11 | 54.50 | 54.50 | 33.25 | 31.50 |
| 4 | 10 | 67.00 | 67.00 | 40.00 | 38.00 |

These prices are based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..$0.05 per cut
2¼ and 2½ in..... .06 per cut
3-in..... $0.09 per cut
3¼ to 4 in..... .10 per cut

*External diameter.

## ELECTRICAL SUPPLIES

**ARMORED CABLE**—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

| B. & S. Size | BX Two Cond. M. Ft. | BX Three Cond. M. Ft. | Lead Two Cond. M. Ft. | Lead Three Cond. M. Ft. |
|---|---|---|---|---|
| No. 14 solid.... | $20.00 | $33.00 | $55.00 | $74.00 |
| No. 12 solid.... | 34.00 | 44.00 | 66.00 | 90.00 |
| No. 10 solid.... | 45.00 | 57.00 | 80.00 | 103.00 |
| No. 8 stranded.. | 72.00 | 92.00 | 112.00 | 156.00 |
| No. 6 stranded.. | 105.00 | 128.00 | 152.00 | 218.00 |

Coils to 1000 ft., +10%; less than coil lots, +20%.

**CONDUIT**—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. Delivered from New York warehouse. Discount of 5 per cent for payment in 10 days; 30 days net.

| Size, Inches | GALVANIZED Conduit | GALVANIZED Couplings | GALVANIZED Elbows | BLACK Conduit | BLACK Couplings | BLACK Elbows |
|---|---|---|---|---|---|---|
| ¾ | $59.07 | $3.40 | $8.14 | $53.85 | $3.09 | $6.97 |
| 1 | 59.67 | 4.08 | 8.19 | 54.45 | 3.71 | 7.02 |
| 1¼ | 60.85 | 4.77 | 8.31 | 55.63 | 4.34 | 7.14 |
| 1½ | 77.55 | 6.84 | 10.94 | 70.47 | 6.23 | 9.41 |
| 2 | 111.17 | 8.93 | 16.34 | 100.71 | 8.13 | 14.06 |
| 2½ | 150.41 | 12.59 | 22.45 | 136.26 | 11.54 | 19.69 |
| 3 | 179.86 | 15.59 | 30.03 | 162.94 | 14.29 | 26.33 |
| 3½ | 242.01 | 20.86 | 54.65 | 219.24 | 19.14 | 47.88 |
| 4 | 382.64 | 29.80 | 90.41 | 346.64 | 27.33 | 79.33 |
| 4½ | 500.40 | 44.66 | 233.65 | 453.32 | 40.97 | 204.12 |
| 5 | 630.26 | 59.90 | 511.67 | 573.66 | 54.98 | 446.44 |
| 6 | 769.04 | 74.67 | 591.65 | 701.96 | 68.51 | 516.27 |
| | 895.85 | 111.37 | 891.90 | 817.71 | 102.13 | 777.77 |
| | 1044.28 | 122.88 | 1240.38 | 953.21 | 112.72 | 1081.94 |
| | 1354.64 | 177.68 | 1547.21 | 1236.49 | 162.91 | 1350.30 |

**CONDUIT BODIES AND FITTINGS**—Black or galvanized:

| | Less Than $15 List | $15 List to $100 | $100 List and Over |
|---|---|---|---|
| Standard package | 15% | 20% | 28% |
| Less than standard package | 10% | 15% | 20% |

**CUT-OUTS**—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

| | | | |
|---|---|---|---|
| S. P. M. L. | $0.12 | D. P. D. B. | $0.31 |
| D. P. M. L. | .16 | T. P. S. B. | .35 |
| T. P. M. L. | .27 | T. P. D. B. | .47 |
| D. P. S. B. | .16 | | |

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

| | 0-30 Amp. | 31-60 Amp. | 60-100 Amp. |
|---|---|---|---|
| D. P. M. L. | $0.27 | $0.70 | $1.75 |
| T. P. M. L. | .40 | 1.00 | 2.30 |
| D. P. S. B. | .35 | .87 | ..... |
| T. P. S. B. | .67 | 1.50 | ..... |
| D. P. D. B. | .65 | 1.75 | ..... |
| T. P. D. B. | 1.12 | 3.00 | ..... |
| T. P. to D. P. D. B. | .75 | 2.10 | ..... |

**FLEXIBLE CORD**—Price per 1,000 ft. in coils of 250 ft.:

| | | |
|---|---|---|
| No. 18 cotton reinforced heavy | | $14.00 |
| No. 16 cotton reinforced heavy | | 17.50 |
| No. 18 cotton reinforced light | | 11.50 |
| No. 16 cotton reinforced light | | 14.00 |
| No. 18 cotton Canvasite cord | | 12.50 |
| No. 16 cotton Canvasite cord | | 13.60 |
| No. 16 super service cord or similar (2 wire) in 1,000 ft. | $54.00 | *59.00 |
| No. 14 super service cord or similar (2 wire) in 1,000 ft. | 82.00 | *89.50 |

*Less than 1,000 ft.

**NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE**—

| 250-Volt | Std. Pkg. | List | 600-Volt | Std. Pkg. | List Each |
|---|---|---|---|---|---|
| 3-amp. to 30-amp., | 100 | $0.15 | 3-amp. to 30-amp., | 100 | $0.30 |
| 35-amp. to 60-amp., | 100 | .30 | 35-amp. to 60-amp., | 100 | .60 |
| 61-amp. to 100-amp., | 50 | .90 | 65-amp. to 100-amp., | 50 | 1.50 |
| 101-amp. to 200-amp., | 25 | 2.00 | 110-amp. to 200-amp., | 25 | 2.50 |
| 201-amp. to 400-amp., | 25 | 3.60 | 225-amp. to 400-amp., | 25 | 5.50 |
| 401-amp. to 600-amp., | 10 | 5.50 | 450-amp. to 600-amp., | 10 | 8.00 |

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 70%.

**RENEWABLE FUSES**—List price each:

| Sizes | 250-Volt List-Price | 600-Volt List-Price | Std. Pkg. Quantity | Carton Quantity |
|---|---|---|---|---|
| 1 to 30-amp..... | $0.50 | $1.10 | 100 | 10 |
| 35 to 60-amp..... | 1.00 | 1.25 | 100 | 10 |
| 65 to 100-amp..... | 2.00 | 3.00 | 50 | 5 |
| 110 to 200-amp..... | 4.00 | 5.00 | 25 | 5 |
| 225 to 400-amp..... | 7.50 | 11.00 | 25 | 1 |
| 450 to 600-amp..... | 11.00 | 16.00 | 10 | 1 |

**REFILLS**—

| | | | | |
|---|---|---|---|---|
| 1 to 30-amp..... | $0.03 ea. | $0.05 | 100 | 100 |
| 35 to 60-amp..... | .05 ea. | .06 | 100 | 100 |
| 65 to 100-amp..... | .10 ea. | .10 | 50 | 50 |
| 110 to 200-amp..... | .15 ea. | .15 | 25 | 50 |
| 225 to 400-amp..... | .30 ea. | .30 | 25 | 25 |
| 450 to 600-amp..... | .60 ea. | .60 | 10 | 10 |

| | |
|---|---|
| Discount Without Contract—Fuses: | |
| Broken cartons | Net list |
| Unbroken cartons | 17% |
| Ten unbroken cartons | 34% |
| Discount Without Contract—Renewals: | |
| Broken cartons | Net list |
| Unbroken cartons | 17% |
| Ten unbroken cartons | 34% |
| Discount With Contract—Fuses: | |
| Broken cartons | 5% |
| Unbroken cartons | 20% |
| Ten unbroken cartons | 36% |
| Discount With Contract—Renewals: | |
| Broken cartons | Net list |
| Ten unbroken cartons | 36% |

Carton quantities may be combined to obtain maximum discounts.

**FUSE PLUGS, MICA CAP**—

| | |
|---|---|
| 0–30 ampere, standard package (500), per 100 | $2.50 |
| 0–30 ampere, less than standard package, per 100 | 2.75 |

**LAMPS**—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

| 100—130 Volt Watts | General Type | Price Each | 200—260 Volt Watts | Special Type | Price Each |
|---|---|---|---|---|---|
| 15 | A 17 | $0.20 | 25 | A 19 | $0.25 |
| 25 | A 19 | .20 | 50 | A 21 | .25 |
| 40 | A 21 | .20 | 100 | A 23 | .45 |
| 50 | A 21 | .20 | ... | ..... | ..... |
| 60 | A 21 | .20 | ... | ..... | ..... |
| 100 | A 23 | .35 | ... | ..... | ..... |

Carton quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

**PLUGS, ATTACHMENT**—

| | Each |
|---|---|
| Porcelain, separable, attachment plug | $0.18 |
| Composition, 2-piece, attachment plug | .27 |
| Swivel attachment plug | .12 |
| Small size, 2-piece plug, composition | .05 |

**RUBBER-COVERED COPPER WIRE**—Per 1000 ft. f.o.b. New York:

| No. | Solid Single Braid | Solid Double Braid | Stranded, Double Braid | Solid Duplex |
|---|---|---|---|---|
| 14 | $4.40 | $6.40 | $7.40 | $12.60 |
| 12 | 6.40 | 7.75 | 9.20 | 16.00 |
| 10 | 8.50 | 10.20 | 11.70 | 21.00 |
| 8 | 12.20 | 14.30 | 16.75 | 29.00 |
| 6 | ..... | ..... | 24.60 | ..... |
| 4 | ..... | ..... | 33.40 | ..... |
| 2 | ..... | ..... | 46.00 | ..... |
| 1 | ..... | ..... | 66.00 | ..... |
| 0 | ..... | ..... | 78.00 | ..... |
| 00 | ..... | ..... | 91.00 | ..... |
| 000 | ..... | ..... | 106.00 | ..... |
| 0000 | ..... | ..... | 131.00 | ..... |

**SOCKETS, BRASS SHELL**—Price each, net:

| | ¼ In or Pendant Cap Key | ¼ In or Pendant Cap Keyless | ¼ In or Pendant Cap Pull | ⅛ In. Cap Key | ⅛ In. Cap Keyless | ⅛ In. Cap Pull |
|---|---|---|---|---|---|---|
| Standard package | $0.12 | $0.10 | $0.16 | $0.16½ | $0.14 | $0.20 |
| Unbroken carton | .14 | .12 | .18 | .18 | .16 | .21 |
| Broken carton | .16 | .14 | .20 | .20 | .18 | .24 |

**WIRING SUPPLIES**—

Friction tape, ¾ in., in less than 100 lb., 28c. per lb.; in 100 lb. lots, 26c. per lb
Rubber tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 27c. per lb
Wire solder, in less than 100 lb., 28c. per lb.; in 100 lb. lots, 26c. per lb.
Soldering paste, 2 oz. cans $1.10 doz

**ENCLOSED SWITCHES, KNIFE**—Safety type, externally operated, 250 d.c or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

| Size, Amp. | Double Pole, Each | Three Pole, Each | Four Pole Each |
|---|---|---|---|
| 30 | $3.50 | $5.70 | $9.00 |
| 60 | 9.00 | 11.00 | 14.00 |
| 100 | 14.00 | 17.00 | 29.00 |
| 200 | 22.00 | 29.00 | 48.00 |

| Discounts: | |
|---|---|
| Standard package | 50% |
| Less than standard package | 45% |